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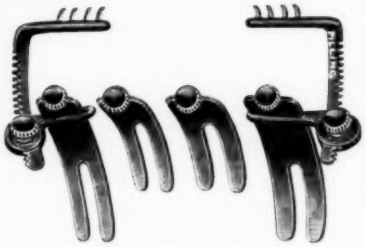

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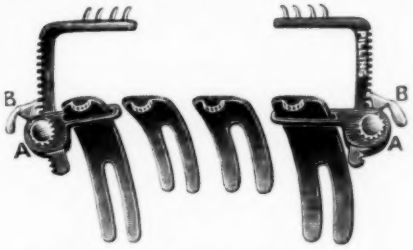

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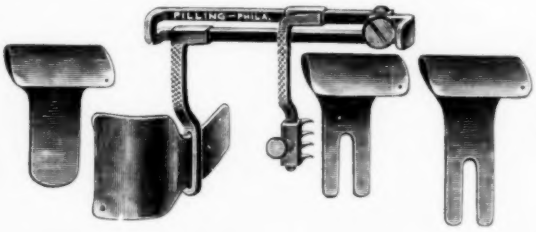

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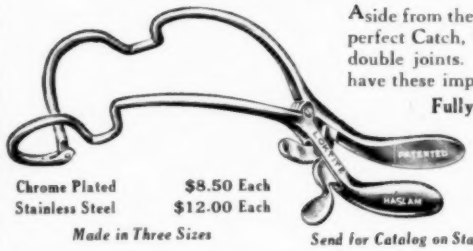

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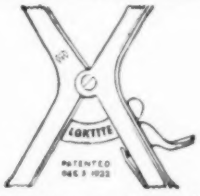

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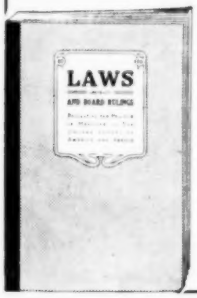

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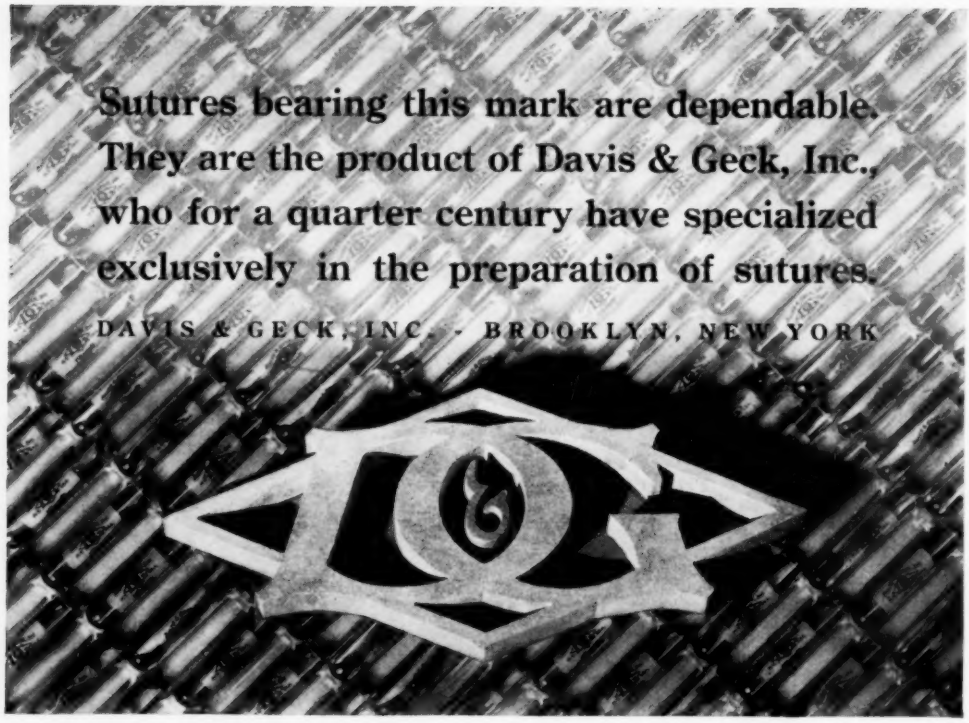
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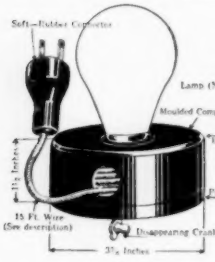

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ARCHIVES OF OTOLARYNGOLOGY

VOLUME 18 JULY, 1933 NUMBER 1

DEVELOPMENT OF THE OTIC CAPSULE

II. THE ORIGIN, DEVELOPMENT AND SIGNIFICANCE OF THE FISSULA ANTE FENESTRAM AND ITS RELATION TO OTOSCLEROTIC FOCI

T. H. BAST, PH.D.
MADISON, WIS.

The fissula ante fenestram is an irregular projection of the periotic connective tissue extending from the angle of junction of the vestibule and the scala vestibuli, through the otic bony capsule to the periosteum of the middle ear just below the pulley of the tensor tympani muscle. Little significance has been attached to this structure. The common view held by former authors is that it is a synchondrosis or possibly a place for expansion of the otic capsule. However, further studies have shown that this structure is constant in human otic capsules even into old age; that the capsule in this region is the usual locus or otosclerotic foci; that the tissue of the fissula resembles and is continuous with the loose periotic tissue of the vestibule at its junction with the scala vestibuli, and that the fissula becomes apparent and its character definite in the same manner and at the same time that the periotic tissue differentiates from the precartilage. These facts lead one to question whether the fissula ante fenestram can be dismissed by simply considering it a synchondrosis. The purpose of this paper is to present developmental and anatomic data regarding this structure which indicate that it has a significance other than that which was formerly attributed to it.

REVIEW OF THE LITERATURE

In my earlier account of the "Ossification of the Otic Capsule in Human Fetuses,"[1] an extended historical account of the fissula ante fenestram and the fissula post fenestram was given. Only enough of the literature will be reviewed here to summarize the views held regarding it.

The earliest reference to the fissula to which I have had access is that of Huschke,[2] published in 1884. He merely referred to it and

These studies were made for the Research Council of the American Otological Society.

1. Bast, T. H.: Ossification of the Otic Capsule in Human Fetuses, Contrib. Embryol. (no. 121) **21**:53 (June) 1930.

2. Huschke, E., in Sömmerring: Lehre von den Eingeweiden und Sinnesorganen, Leipzig, Leopold Voss, 1844, vol. 5, p. 828.

stated that it extends from the vestibule toward the groove of the tensor tympani. In 1845 Hyrtl [3] published a picture of corrosion of the ear of a new-born infant which showed a bulblike outpunching from the vestibule in front of the oval window, but he did not say anything about it. In 1873 Hyrtl, in describing the ear of Hyaena spelaea, wrote: "Before the oval window one finds in the outer wall of the vestibulum a small evagination which in the corrosion appears as a low stumplike process." He said that it is absent in most animals, but he found it in a young antelope where a diverticulum from the sacculus projected into it. In 1890 Siebenmann,[4] after describing the inconstant fissula post fenestram, wrote: "Another opening, which is more slitlike, occurs immediately in front of the oval window, the fissula ante fenestram, where the vestibule unites with the upper wall of the scala vestibuli." He compared this structure with the evagination containing the diverticulum of the sacculus which Hyrtl described, and considered it in man as a rudiment of the evagination found in the hyena and antelope. Siebenmann was the first to call this structure the fissula ante fenestram. Of course he, as also did the earlier writers, described the structure as it appeared in corrosions and did not describe its histologic nature. However, Siebenmann located it accurately as being a slitlike outpunching from the periotic labyrinth at the point where the vestibule unites with the upper wall of the scala vestibuli.

In 1916 Perozzi,[5] after working in Siebenmann's laboratory, gave a histologic account of the otic capsule and in particular of the evagination of the vestibule in front of the oval window and named it, in honor of his uncle and teacher, Cozzolino's zone. The following year O. Mayer [6] referred to it as Cozzolino's zone, and described it as a synchondrosis. In 1920 and 1921 Perozzi [7] wrote a series of five articles in which he described in detail the fissula (Cozzolino's zone) as shown by sections from a comprehensive series of fetal, postnatal and adult ears. He described it as a fissure-like band of connective tissue which extends from the point where the vestibule joins with the upper wall of the scala vestibuli through the otic capsule to the middle ear just in front of the oval window. He noted the structure first in fetuses at the time the capsule became cartilaginous. Other workers state that the cochlear and vestibular capsules chondrify separately, and

3. Hyrtl, Joseph: Verglichend-anatomische Untersuchungen über das innere Gehörorgan des Menschen und der Säugethiere, Prag, F. Ehrlich, 1845.

4. Siebenmann, Friedrich: Die Korrosions-Anatomie des menschlichen Ohres, Munich, J. F. Bergmann, 1890.

5. Perozzi, Luigi: Contributo all'etiologia dell'otospongiosi, Arch. ital. di otol. **27**:85, 1916.

6. Mayer, Otto: Untersuchungen über die Otosklerose, Vienna, Alfred Hölder, 1917.

7. Perozzi, Luigi: Ricerche anatomica intorno alla capsula del labirinto, Arch. ital. di otol. **31**:214, 321 and 353, 1920; **32**:46 and 65, 1921.

that the union of these two cartilaginous anlagen is not complete, thus resulting in a synchondrosis in the capsule anterior to the stapes. Perozzi, however, considered this zone as a place which permitted growth or expansion of the capsule. Thus he wrote: "I believe that through this layer of perichondrium, placed in the thickness of the capsule, the cavity of the cochlea can more greatly augment and permit the cochlear canal to describe its spirals. In fact, at the moment the cochlear canal augments the most, this zone is larger and the internal layer of cartilaginous young cells is thicker; this would prove a greater activity." Regarding the histologic structure of the zone, he stated that at first it consists of a peculiar loose connective tissue continuous with the loose tissue which fills the periotic space in young fetuses. This tissue extends from the vestibule to the middle ear. In older fetuses the tissue becomes denser and resembles perichondrium. The tissue is surrounded by the cartilage of the capsule. Later when the capsule ossifies, the part surrounding this tissue remains cartilaginous even in adult ears.

In 1922, Kosokabe,[8] also a student of Siebenmann, used the term Cozzolino's zone. In describing the zone in a 1½ to 2 month fetus, he said that there is a raphe-like line between the cartilaginous medial part of the cochlear capsule and the capsule of the canal which is not cartilaginous. He said: "In it one can see closely packed embryonic tissue with irregularly placed cells, which have the appearance of perichondrial cells. One sees in it no blood vessels. This zone, already present in the precartilaginous state, appears from a developmental standpoint as the incomplete slitlike union of the vestibule and the cochlea. Later the area becomes smaller; the form and structure remain the same until the period of ossification." Claoué [9] pictured the fissula ante fenestram as seen in section. He regarded it, as did Mayer and Perozzi, as a place where two processes of chondrification meet but are separated by means of a perichondrium. They call this a synchondrosis.

In a recent article Guggenheim [10] advanced a phylogenetic interpretation of the fissula. He regarded it as a rudiment of the ductus fenestra ovalis of the frog. He wrote: "The fissula ante fenestram, in which otosclerosis often begins, is a vestigial structure which may show cartilage throughout life and is therefore predisposed to mesenchymal invasion. The primary involvement being of a vestigial structure suggests its regressive character. The homologue of the fissure is the canalis fenestrae ovalis of the frog."

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8. Kosokabe, H.: Ueber die Knorpelflugen in der Labyrinths Kapsel, Stuttgart, Alfred Kernen, 1922.

9. Claoué, R.: Oreille interne: Etude anatomopathologique, clinique, microscopique et expérimentale, Paris, Norbert Maloine, 1927.

10. Guggenheim, L. K.: The Cause of Otosclerosis, Ann. Otol., Rhin. & Laryng. **41**:1149 (Dec.) 1932.

HISTOLOGIC FINDINGS

This study was made on serial sections and reconstructions of the internal ears of fifty-five human fetuses ranging from 8 weeks to full term. In this series the youngest fetus to show a fissula was a human fetus of 43 mm. crown-rump length. In the next younger fetus which I studied, a human fetus of 30 mm. crown-rump length, the fissula could not be seen. The fissula therefore must become differentiated some time between the 30 mm. and the 43 mm. stage. In the latter stage it was not fully formed, but could be clearly seen only at its vestibular end. In the two youngest fetuses which I studied, one of 25 mm. and one of 30 mm., the otic capsule was for the most part precartilage, including the area which later becomes the periotic labyrinth, scala vestibuli, scala tympani and fissula ante fenestram. In the posterior part of the capsule in the canal region and around the internal auditory meatus, some of the precartilage had changed into young cartilage (figs. 1 and 2). This metamorphosis of precartilage to true cartilage occurs between the 25 and 50 mm. stage, or between the ages of 8 and 10 weeks (figs. 3 and 4).

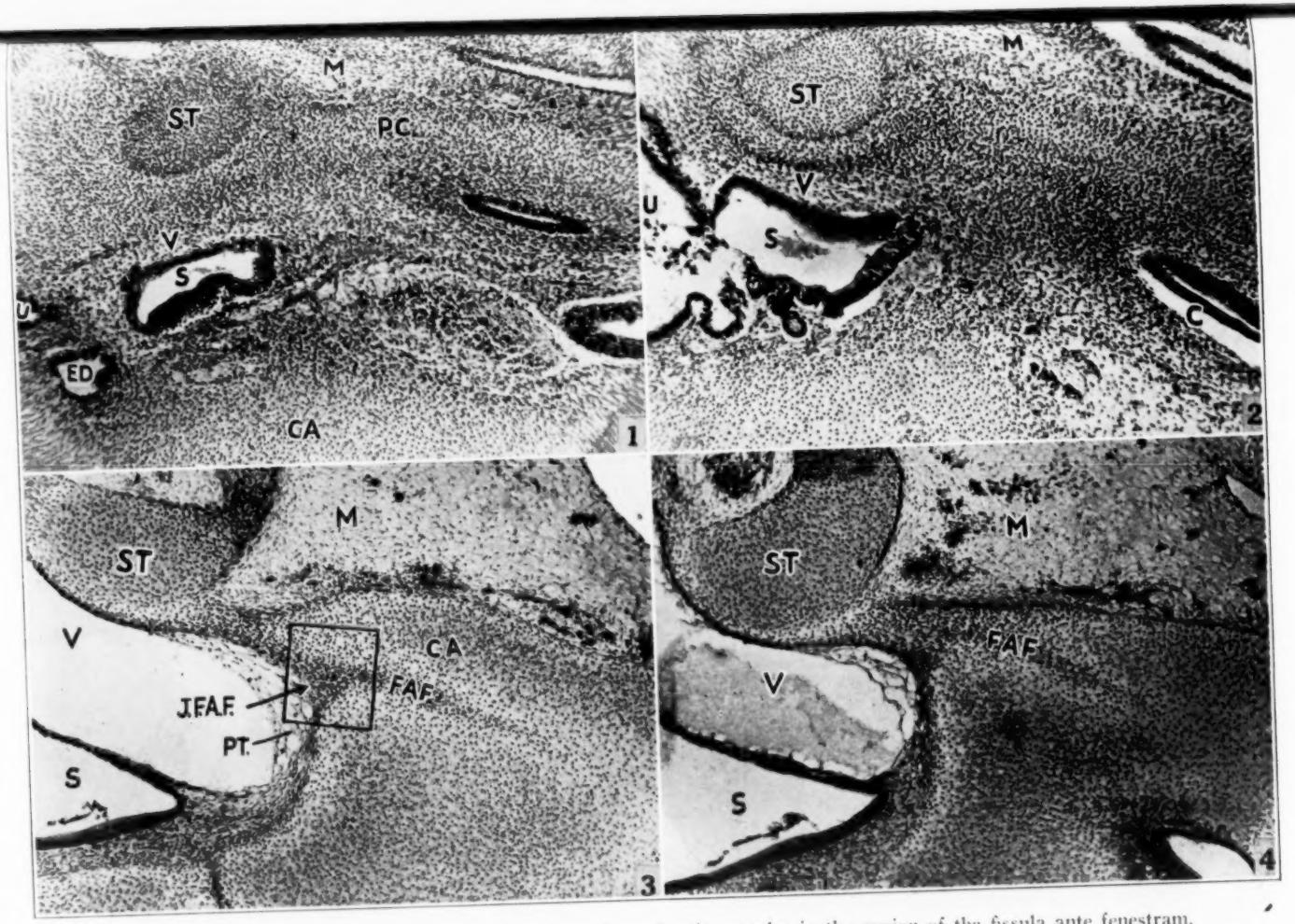
During the same period that metamorphosis takes place, the precartilage immediately surrounding the otic cavity begins a retrogressive change which eventually results in the periotic spaces such as the vestibule, scala tympani and scala vestibuli. This process has been described by Streeter[10a] and Foley[10b]. My observations agree with theirs as to the formation of the periotic spaces. Figures 33 and 34 are drawings of a reconstruction of a 50 mm. human fetal inner ear, showing the extent of the formation of the periotic tissue.[11]

The earliest site of the formation of periotic tissue is between the saccule and the stapes foot-plate. From this place it spreads to form the vestibule and the scala vestibuli. The scala tympani originates in the region of the round window about the same time.

10a. Streeter, George L.: The Histogenesis and Growth of the Otic Capsule and Its Contained Periotic Tissue-Spaces in the Human Embryo, Contrib. Embryol. (no. 20) **7**:5, 1918.

10b. Foley, J. O.: The Cytological Process Involved in the Formation of the Scalae of the Internal Ear, Anat. Rec. **49**:1, 1931.

11. A word of explanation is necessary. Although the extent of the vestibule, scala tympani and scala vestibuli in my model is similar to that pictured by Streeter, the ages are different. Streeter's specimen was from a 100 mm. fetal ear and mine, from a 50 mm. fetal inner ear. Streeter modeled the periotic spaces when quite fully formed, whereas I modeled all the periotic tissues which showed only a small degree of space formation. Had Streeter modeled the young periotic tissue in his 100 mm. human fetal ear, his model would have shown much more of the periotic labyrinth. Or had I modeled only the fully excavated areas as Streeter did, my model would show only a small space between the stapes and the saccule.



Figures 1 to 27 are photomicrographs of sections through otic capsules in the region of the fissula ante fenestram.

Fig. 1.—Embryo 87; size, 25 mm. crown-rump length; age, about 8 weeks. The capsule is mostly precartilage, and the fissula is not yet seen.

Fig. 2.—Embryo 92; size, 30 mm. crown-rump length; age, about 8½ weeks.

Figs. 3 and 4.—Embryo 86; size, 50 mm. crown-rump length; age, about 10 weeks. Figure 3 shows the fissula ante fenestram (*F.A.F.*) as it communicates with the vestibule (*V*). Figure 4 shows the fissula a little higher up where the fissula communicates with the stapes joint. The area outlined in figure 3 is magnified in figure 29.

In figures 1 to 4, *M* indicates middle ear; *S*, stapes; *V*, vestibule; *S*, saccule; *U*, utriculus; *P.C.*, precartilage; *CA*, cartilage; *C*, cochlea; *J.F.A.F.*, junction of fissula ante fenestram and the vestibule; *F.A.F.*, fissula ante fenestram; *P.T.*, periotic tissue.

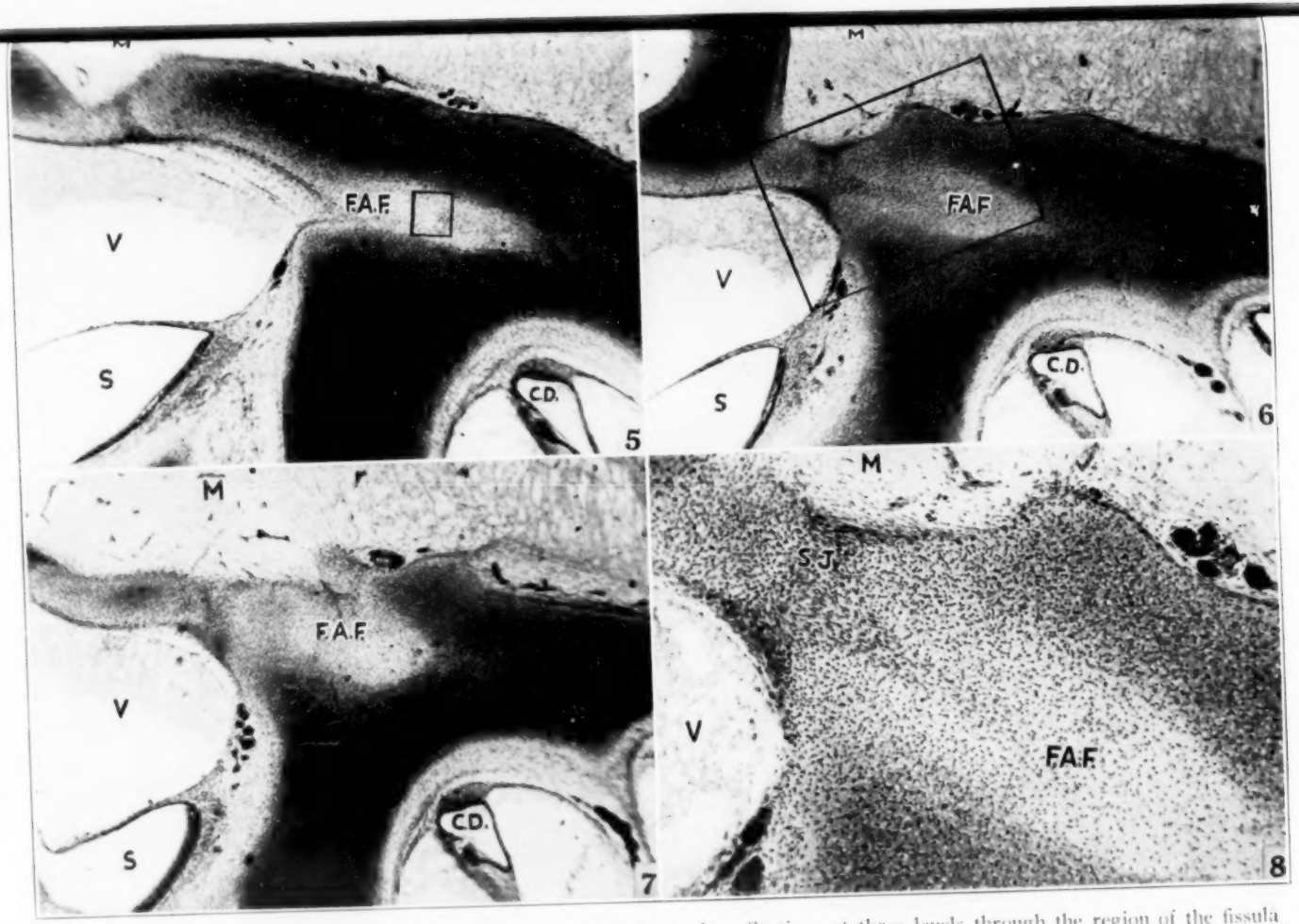
ORIGIN OF THE FISSULA ANTE FENESTRAM

At the angle of junction of the vestibule and the scala vestibuli there occurs an evagination of the periotic tissue into the capsule.

It is directed upward and toward the middle ear and is known as the fissula ante fenestram (*f.a.f.* in figs. 33 and 34). In the 25 and 30 mm. fetuses this area is occupied by precartilage (figs. 1 and 2). Between the 30 and 50 mm. stage the precartilaginous capsule changes to cartilage except around the otic labyrinths, where the periotic tissue spaces form, and where the fissula ante fenestram occurs (figs. 3 and 4). In these places the precartilage undergoes a regressive dedifferentiation. The rounded precartilage cells become more stellate, and small spaces form between the cells; these spaces become larger and larger, coalesce and thus form the periotic spaces. In the fissula ante fenestram the early space formation is marked at its vestibular end, but in the main part of the fissula the stellate cells become more spindle-shaped to form a cellular embryonic connective tissue (figs. 3 and 29). As in the younger fetuses the site of the fissula is occupied by precartilage (figs. 1 and 2), the structure cannot be considered a synchondrosis. But as a regressive change takes place in the precartilage similar to that which occurs in the formation of the periotic spaces and as the fissula is continuous with the periotic tissue of the vestibule, one must conclude that the fissula ante fenestram has its origin in relation and in manner similar to the periotic labyrinth. The relation and origin suggest that the function of the fissula may be related to the function of the periotic labyrinth.

DEVELOPMENT OF THE FISSULA AND SURROUNDING CAPSULE

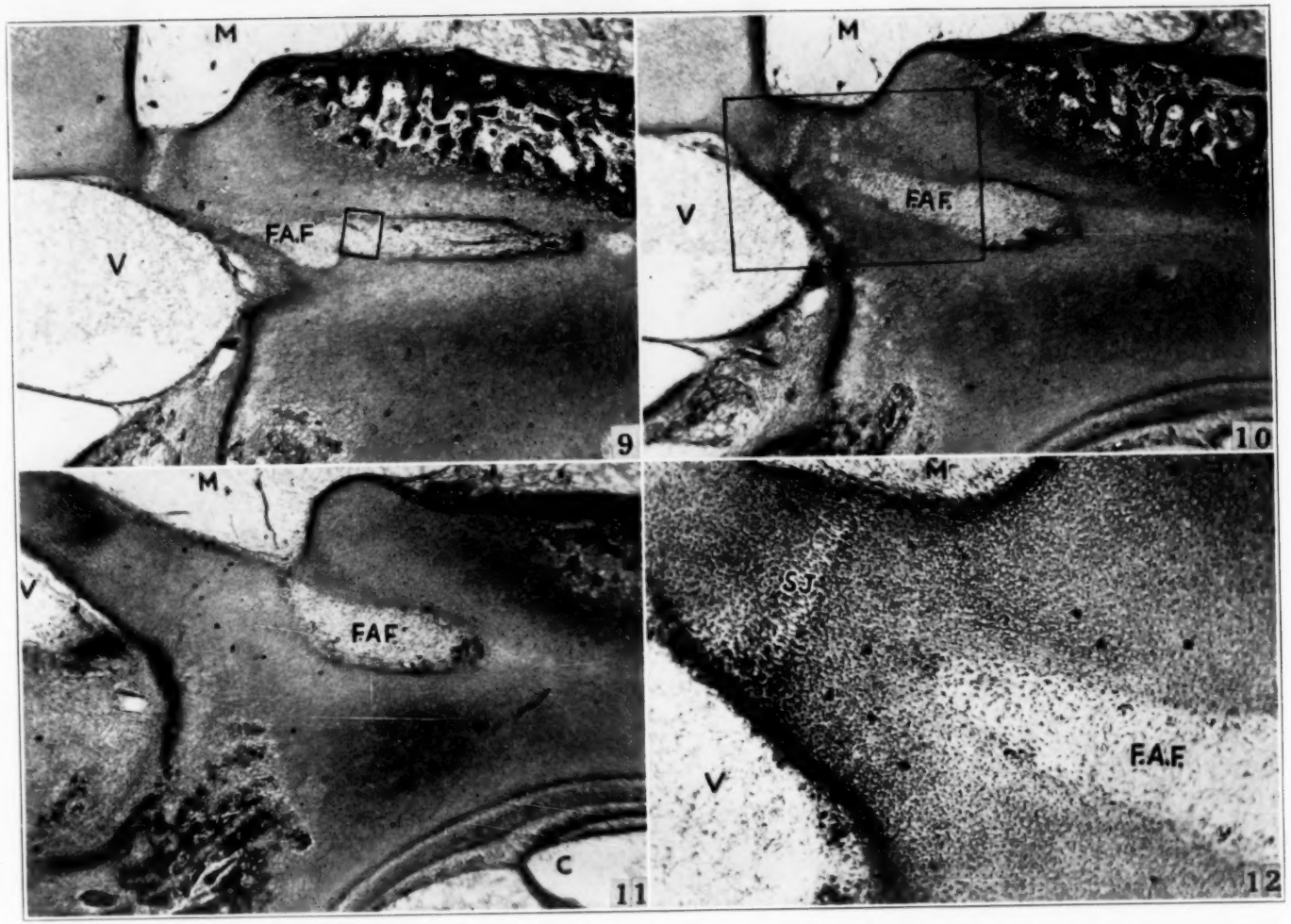
The story of the development of the fissula and the surrounding capsule is pictured in figures 3 to 28. These seven stages are representative of the fifty-five fetal ears studied. Figures 3 and 4 are photomicrographs of two horizontally cut sections at different levels through the otic capsule of a 50 mm. or 10 week old human fetus. They show the early stage in the development of the fissula ante fenestram. In figure 3, a section near the lower part of the fissure, the latter is seen as a narrow cellular tissue budding out from the vestibule and extending into the newly formed cartilaginous otic capsule. The tissue of the fissula is a somewhat altered precartilage. Many of the cell nuclei are necrotic, and tissue spaces are forming between the cells. This formation of tissue spaces is well marked in the region of the junction of the fissula with the vestibule. The main part of the fissula is still quite cellular. The histologic detail is better shown in figure 29, which is an enlargement of the area outlined in figure 3. In figure 4, which is a section about 150 microns above the one shown in figure 3, the fissula is directed toward and almost meets the stapes joint. It is not so well



Figs. 5, 6 and 7.—Embryo 22; size, 100 mm.; age, about 14 weeks. Sections at three levels through the region of the fissula ante fenestram. Figure 5 shows the communications of the fissula with the vestibule. Around the fissula the cartilage is very poorly stained. The area outlined is enlarged in figure 30. Figure 6 shows the fissula in the region of the stapes joint. Figure 7 shows the opening of the fissula into the middle ear. A blood vessel is entering the fissula from the middle ear.

Fig. 8.—An enlargement of the area outlined in figure 6.

In figures 5 to 8, *M* indicates middle ear; *V*, vestibule; *S*, saccule; *F.A.F.*, fissula ante fenestram; *C.D.*, cochlear duct; *S.J.*, stapes joint.



Figs. 9, 10 and 11.—Fetus 13; size, 161 mm. crown-rump length; age, about 19½ weeks. Sections at three levels through the region of the fissula ante fenestram. At this stage the fissula reaches its greatest dimensions. Ossification of the capsule progresses toward the fissula. The area outlined in figure 9 is enlarged in figure 31. Small blood vessels are seen in the fissula in figures 9 and 11.

Fig. 12.—An enlarged view of the area outlined in figure 10.

In figures 9 to 12, *M* indicates middle ear; *V*, vestibule; *C*, cochlea; *F.A.F.*, fissula ante fenestram; *S.J.*, stapes joint.

differentiated as in lower sections. In sections above this level it gradually fades out, and in this fetus no communication is made with the middle ear. The region where the communication with the middle ear later occurs consists of very young cartilage just beyond the precartilage stage. These facts again show that the fissula is not a synchondrosis, but that it develops as an evagination of the periotic tissue. It is well formed at its junction with the vestibule, but has not yet pushed through the capsule to its communication with the middle ear. Again the site of its junction with the middle ear at this stage is cartilage, which, according to the theory of synchondrosis, should never form.

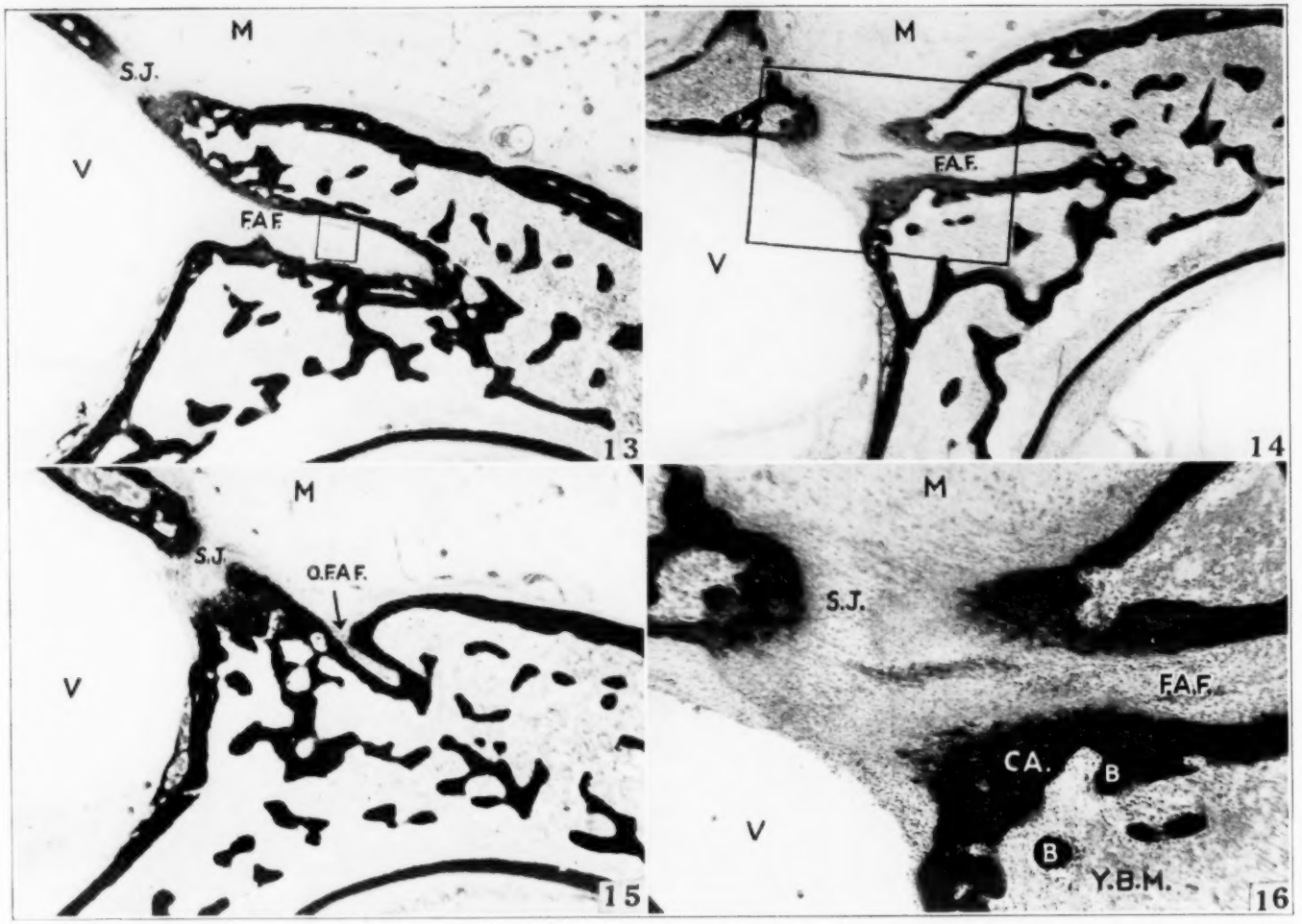
During the next few weeks there occurs a gradual enlargement of the fissula. This is shown in figures 5 to 8, which are sections from a 100 mm. or 14 week old human fetus. The loose periotic tissue from the vestibule dips deeper into it, and the cartilage around it is poorly stained and appears necrotic. The tissue in the fissula shows many necrotic nuclei and a marked formation of tissue spaces. This is shown in figure 30, which is an enlargement of the area outlined in figure 5. The tissue cells in the fissula a little farther removed from the vestibule show a tendency toward a return to the early precartilage cell type, but the cells are far apart with tissue spaces between them, and the whole tissue is poorly stained (fig. 6 and fig. 8, which is an enlargement of area outlined in fig. 6). In figures 6 and 8 it will also be noted that the tissue of the fissula as it approaches the stapes joint retains the more cellular appearance similar to the tissue of the fissula in the earlier stage shown in figures 3, 4 and 29. It is a late part of the fissula to develop and in most cases retains a cellular nature much like the tissue of the stapes joint. As will be noted from figures 4, 8, 12, 16, 20, 24 and 28, the fissula in most cases extends to the stapes joint. The long axes of the connective tissue cells of the fissula are continuous with and lie in the same plane as those of the stapes joint.

Figure 7 is a photomicrograph of a section through the upper part of the fissula (*F.A.F.*), at the point where it communicates with the middle ear. In the 50 mm. fetus this communication was not yet formed. In the 100 mm. fetus (fig. 7) a blood vessel will be seen entering the fissula from the side of the middle ear. The tissue of the fissula around this entering vessel is poorly stained necrotic young cartilage similar to that around the fissula in figure 6. This stage shows: (1) that the fissula is enlarging, (2) that the fissula is developed furthest at its vestibular end, where the formation of tissue spaces of the vestibule extends a considerable way into it, (3) that the cartilage around the early fissula is poorly stained and (4) that the fissula communicates with the middle ear from whence it receives a blood vessel. It appears, further, that two processes are at work in the formation of the fissula:

Fig. 12.—An enlarged view of the area outlined in figure 10.

In figures 9 to 12, *M* indicates middle ear; *V*, vestibule; *C*, cochlea; *F.A.F.*, fissula ante fenestram; *S.J.*, stapes joint.

n figures 9 and 11.



Figs. 13, 14 and 15.—Fetus 51; size, 210 mm. crown-rump length; age, about 24 weeks. Sections at three levels through the region of the fissula ante fenestram. The capsule at this stage in the region of the fissula is intracartilaginous bone and an internal and external rim of perichondral bone. An irregular rim of cartilage, which remains throughout life, separates the fissula from the capsule of the bone. Small blood vessels are seen in the fissula. The area outlined in figure 13 is enlarged in figure 32.

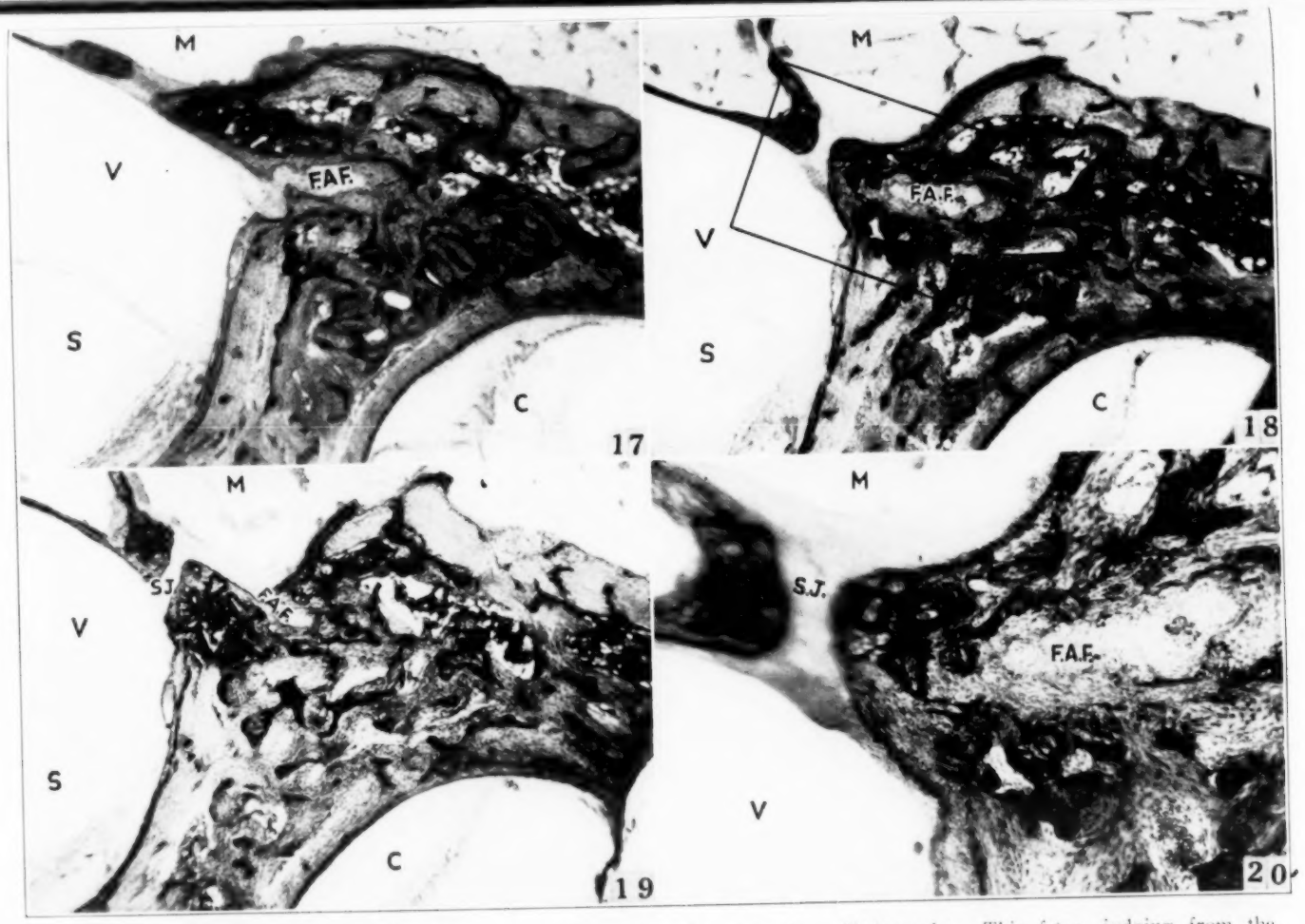
Fig. 16.—An enlargement of the area outlined in figure 14.

In figures 13 to 16, *M* indicates middle ear; *V*, vestibule; *F.A.F.*, fissula ante fenestram; *O.F.A.F.*, opening of the fissula ante fenestram into the middle ear; *C.A.*, cartilage; *B*, intrachondral bone; *S.J.*, stapes joint; *Y.B.M.*, young bone marrow.

sula from the capsule of the bone. Small blood vessels are seen in the fissula. The area outlined in figure 18 is enlarged in figure 32.

Fig. 16.—An enlargement of the area outlined in figure 14.

In figures 13 to 16, *M* indicates middle ear; *V*, vestibule; *F.A.F.*, fissula ante fenestram; *O.F.A.F.*, opening of the fissula ante fenestram into the middle ear; *C.L.*, cartilage; *B*, intrachondral bone; *S.J.*, stapes joint; *S.B.M.*, semicircular membrane.



Figs. 17, 18 and 19.—Fetus 66; size, 290 mm. crown-rump length; age, about 31½ weeks. This fetus, judging from the degree of bone formation, is very likely a good deal older than 31½ weeks, which is the age determined from the size. The dark areas in the capsule are intrachondral bone (cartilage islands of other authors); the lighter areas of bone around the dark areas are endochondral bone.

Fig. 20.—An enlargement of the area outlined in figure 18.

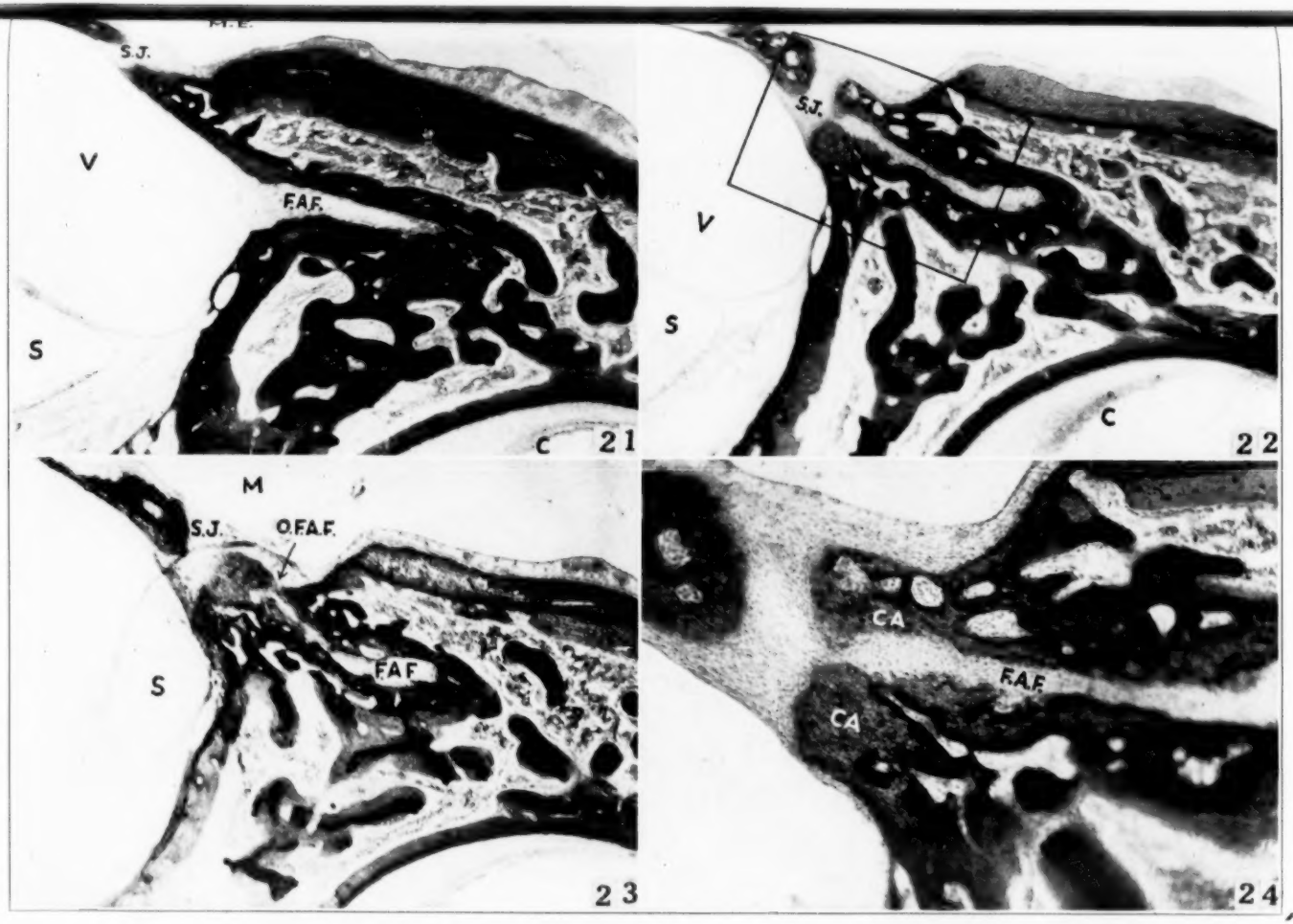
In figures 17 to 20, *M* indicates middle ear; *V*, vestibule; *S*, saccule; *C*, cochlea; *S.J.*, stapes joint; *F.A.F.*, fissula ante fenestram.

(1) the process of the formation of tissue spaces, continuous with and like that which forms the periotic labyrinth, and (2) the formation of a vascular bud at the end of the fissula where the middle ear is situated, which results in a destruction of cartilage similar to that found in the cartilage of the canal region described in a recent paper.[12]

It is difficult to determine whether the fissula enlarges at the expense of the surrounding cartilage or whether the enlargement is entirely due to the spreading of the cells within the fissula owing to the formation of tissue spaces. However, the facts that there are necrotic nuclei in the fissula, indicating nongrowth, and that the cartilage around the fissula is light-staining and necrotic indicate that the fissula enlarges at least in part at the expense of the surrounding cartilage. This enlargement of the fissula has been correlated with the rapid expansion of the entire internal ear and its capsule at this fetal period. Perrozi thought that the enlarging fissula permitted the enlargement of the cochlea and its capsule. I incline toward the view that the fissula enlarges at this period of growth not merely to permit the cochlea and capsule to enlarge, but for the same reason that the rest of the internal ear enlarges. In other words, the fissula is a structure of other importance than a mere means for permitting augmentation of the capsule and cochlea.

During the next few weeks of fetal life, the fissula continues its growth, to reach its maximum size and definite delamination from the surrounding cartilage in fetuses of from about 4 to 4½ months and of from 126 to 140 mm. crown-rump length. This is also the period when the cochlea and vestibule attain full size and when the early ossification of the capsule begins.[1] The definite delamination of the fissula is accomplished at the vestibular end by the endochondrium of the vestibule, which dips into the fissula and separates it from the surrounding cartilage. Near the middle ear the vascular bud which eroded the cartilage brings with it connective cells which line up along the eroded cartilage to form a sort of endochondrium continuous with the endochondrium of the middle ear, which definitely outlines the fissula. The clear delamination and maximum size of the fissula are attained at about the same time that the cochlea reaches its maximum size. If the fissula serves as a center of growth for the expanding cochlear capsule, one would expect that it would be almost used up and small at the time the maximum growth of the cochlea and the capsule was attained. This, however, is not the case. Figures 9, 10, 11, 12 and 31 show various views and magnifications of the fissula of a 161 mm. or 19½ week old

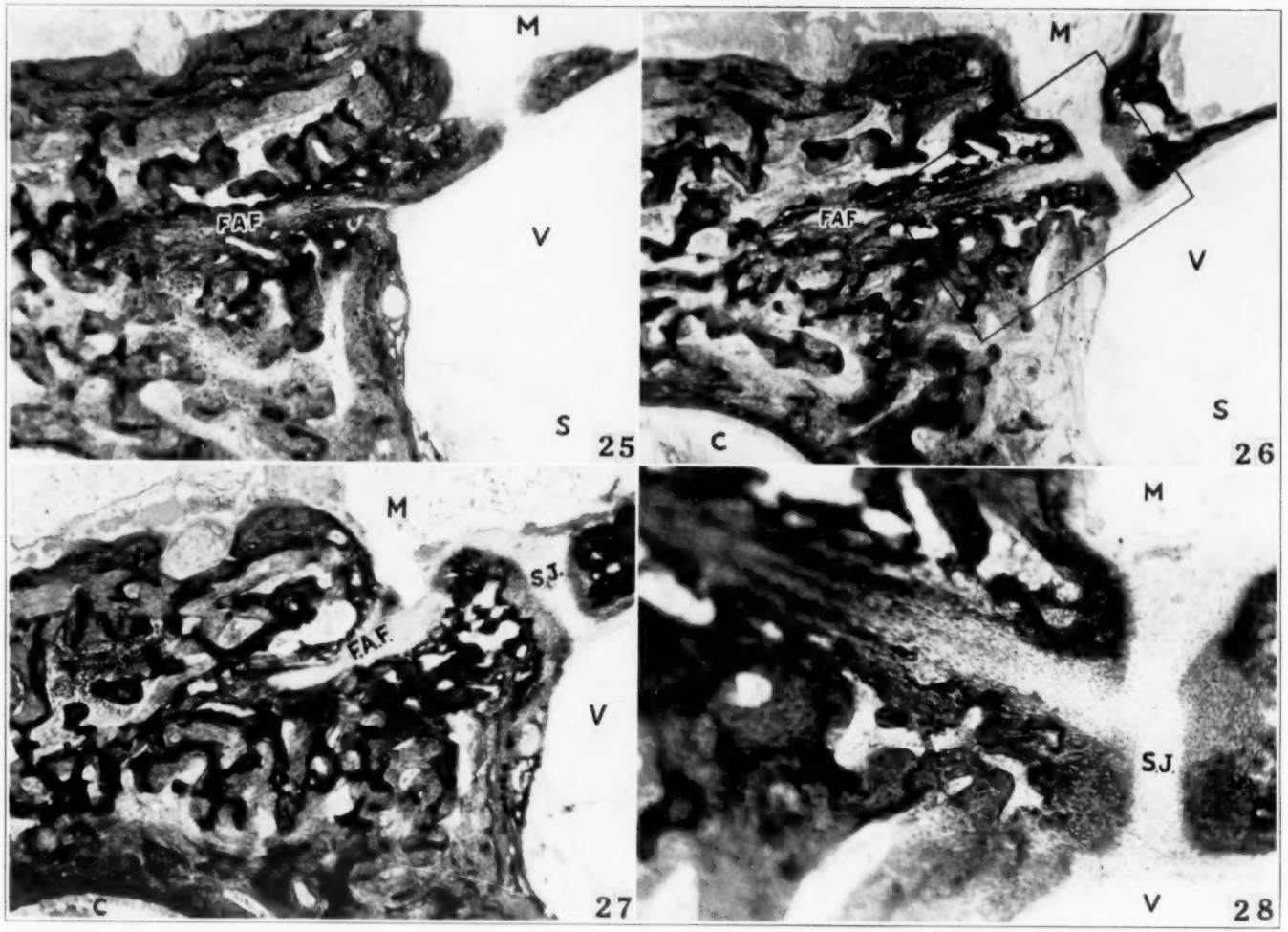
12. Bast, T. H.: Development of the Otic Capsule: I. Resorption of the Cartilage in the Canal Portion of the Otic Capsule in Human Fetuses and Its Relation to the Growth of the Semicircular Canals, Arch. Otolaryng. **16**:19 (July) 1932.



Figs. 21, 22 and 23.—Fetus 60; size, 305 mm. crown-rump length; age, about 34⅓ weeks. In this fetus the middle ear opening of the fissula ante fenestram is small and very near the stapes joint. The opening into the vestibule is prominent. The dark areas of bone are intrachondral bone and are surrounded by endochondral bone.

Fig. 24.—An enlargement of the area outlined in figure 22. It shows the rim of cartilage separating the fissula from the surrounding bone.

In figures 21 to 24, *M* indicates middle ear; *S.J.*, stapes joint; *V*, vestibule; *S*, saccule; *F.A.F.*, fissula ante fenestram; *C*, cochlea; *O.F.A.F.*, opening of the fissula in the middle ear.



Figs. 25, 26 and 27.—Fetus 67; size, 370 mm. crown-rump length; age, full term. In this fetus the fissula is smaller than usual. The opening into the middle ear is large, but the vestibular end of the fissula is small.

Fig. 28.—An enlargement of the area outlined in figure 26.

In figures 25 to 28, *M* indicates middle ear; *V*, vestibule; *S*, saccule; *C*, cochlea; *F.A.F.*, fissula ante fenestram; *S.J.*, stapes joint.

human fetus at the time the cochlea and fissula reach their maximum size. From these pictures it will be noted that the character of the tissue in the fissula is quite different from that shown in figures 5, 6, 7, 8 and 30. In place of the necrotic tissue there is an actively growing tissue (fig. 31). This change from degenerating to growing tissue within the fissula is brought about by the advent of the entrance of blood vessels into the fissula from the middle ear. In the 100 mm. fetus (fig. 7) a blood vessel just entered the fissula from the middle ear, but in the rest of the fissula no vessels are seen. In the 161 mm. fetus (figs. 9 to 12 and 31), numerous vessels are seen throughout it, and the connective tissue cells show marked activity.

Ossification of the capsule is progressing rapidly at this stage, as seen in figure 9. During the subsequent three or four weeks the cartilaginous capsule surrounding the fissula becomes completely ossified, as shown in figures 13 to 15, which are from a 210 mm. or 24 week old human fetus. The fissula thus is completely surrounded by bone except where it communicates with the vestibule and where it butts against the annular ligament of the stapes.

The tissue of the fissula has also changed its character from that seen in the 161 mm. stage. At that stage the connective tissue of the fissula showed actively growing fibroblasts, but in the 210 mm. fetus the tissue is again quiescent, the cells are small with round nuclei, some finely fibrillar intercellular substance is present, and around a number of the cells vacuolation is marked (fig. 32). Blood vessels are numerous, and in figures 14 and 16 one is seen entering the annular ligament of the stapes from the fissula.

In the subsequent development of the fissula, represented by figures 17 to 28, two changes occur: 1. The connective tissue of the fissula bordering the fissula next to the surrounding bony capsule changes to cartilage; this cartilage normally remains as cartilage throughout life. 2. The connective tissue of the central part of the fissula becomes somewhat looser than that shown in figure 32 and remains as a fine reticular connective tissue containing small blood vessels. By means of these two processes the fissula becomes narrower because the peripheral part of the fissula changes to cartilage. The thus somewhat narrowed fissula remains throughout life. The shape and size of the fissula, however, vary in different persons. This is already seen in fetuses. Thus in the 305 mm. fetus (figs. 21 to 24), the fissula is large, but its communication with the middle ear is small, whereas in the full-term fetus (figs. 25 to 28) the fissula is very narrow, almost obliterated in spots, but the communication with the middle ear is large. Again in some fetuses the opening to the middle ear is very near the stapes joint; in others, it is quite distant from the oval window.

Fig. 28.—An enlargement of the area outlined in figure 26.

In figures 25 to 28, *M* indicates middle ear; *V*, vestibule; *S*, saccule; *C*, cochlea; *F.A.F.*, fissula ante fenestram; *St*, stapes

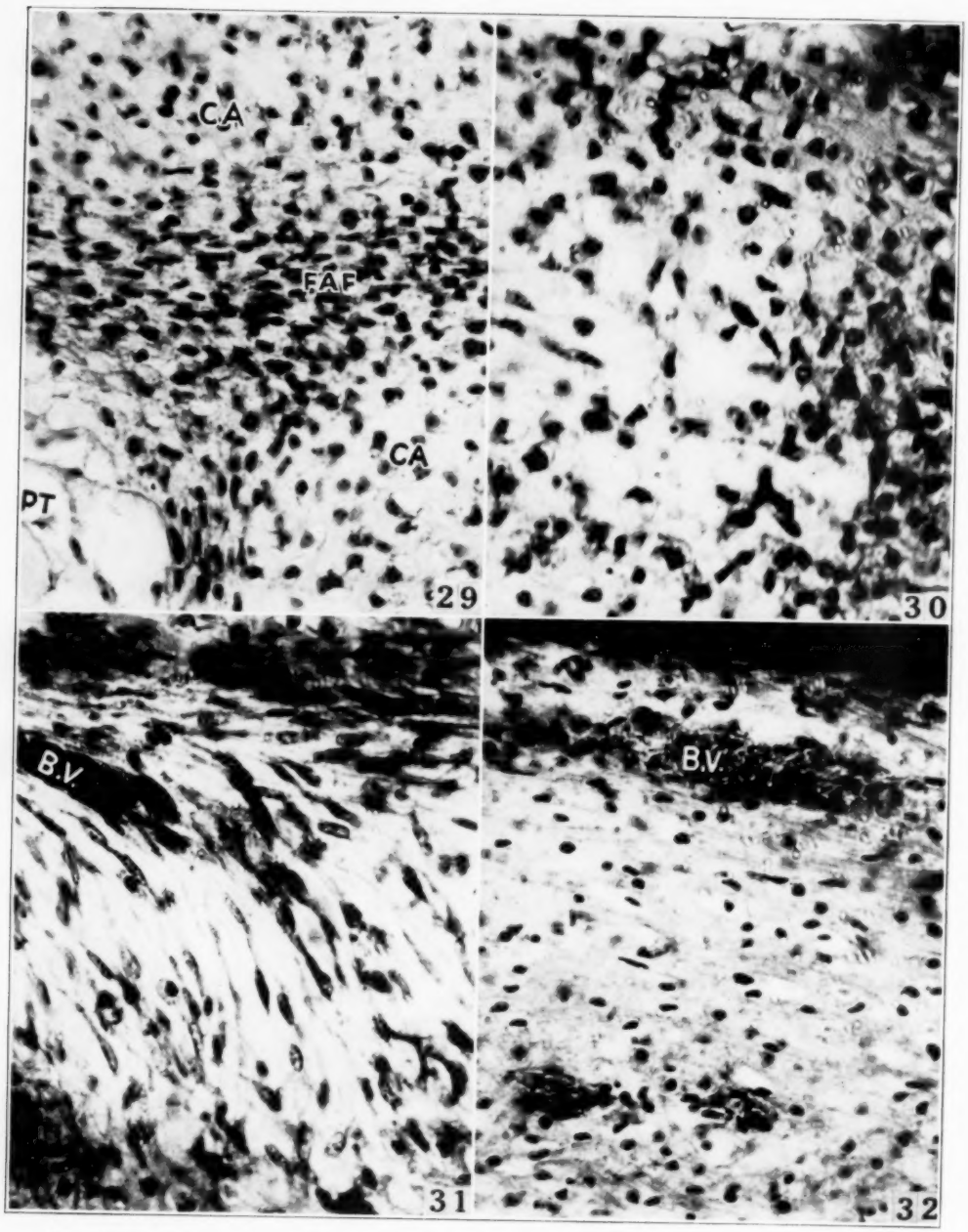
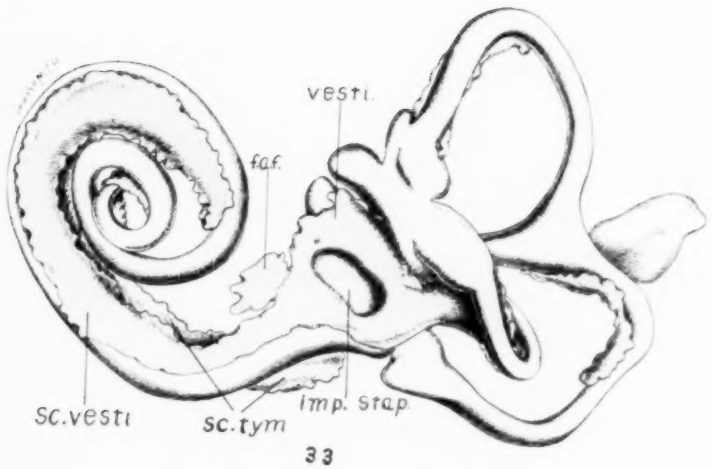


Fig. 29.—Enlarged view of area outlined in figure 3. It shows the vestibular end of the fissula. The loose vacuolated tissue at *PT* is periotic tissue. This loose vacuolated tissue extends into the fissula for a little way. The rest of the tissue of the fissula ante fenestram (*F.A.F.*) is cellular, but many of the nuclei are necrotic. *CA* indicates cartilage.

Fig. 30.—Enlarged view of the area outlined in figure 5. The fissula is much larger in this fetus than in the one shown in figure 29. The tissue is very necrotic and vacuolated. The fissula enlarges by destruction of the surrounding cartilage shown at lower left corner of the figure.

Fig. 31.—Enlarged view of the area outlined in figure 9. Active fibroblasts are seen invading the fissula. A blood vessel (*B.V.*) is seen.

Fig. 32.—Enlarged view of the area outlined in figure 13. The tissue of the fissula is denser, with fine intercellular fibers between the fibroblasts. Vacuolated areas around some of the cells are noted. A large blood vessel (*B.V.*) is seen near the upper part of the figure and several smaller vessels at the bottom.



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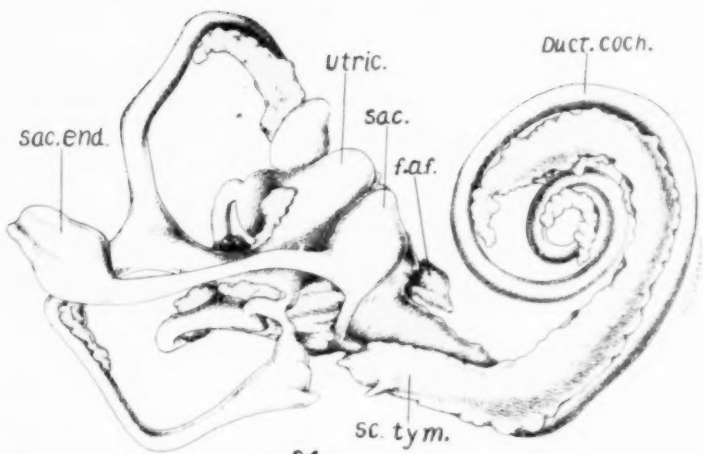

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Fig. 33.—Fetus 86; size, 50 mm. crown-rump length; age, about 10 weeks. Anterior view of a model of the otic labyrinth showing the development of the periotic tissue and spaces and the fissula ante fenestram.

Fig. 34.—Posterior view of the same model shown in figure 33.

In figures 33 and 34, *vesti.* indicates vestibule; *f.a.f.*, fissula ante fenestram; *Sc. vesti.*, scala vestibuli; *Sc. tym.*, scala tympani; *imp. Stap.*, impression of stapes; *Sac. end.*, endolymphatic duct; *Sac.*, sacculus; *Utric.*, utriculus; *Duct. coch.*, cochlear duct.

SUMMARY

The tissue of the fissula arises, as does the periotic tissue, from precartilage. 1. The precartilage undergoes a regressive change to form a vacuolated reticular tissue. 2. With the entrance of blood vessels from the middle ear, the tissue undergoes new growth, filling the fissula with fibroblasts which form a fine fibrillar connective tissue. 3. At the periphery of the fissula this connective tissue changes to cartilage, whereas in the center of the fissula a loose vacuolated vascular connective tissue is formed.

RELATION OF THE FISSULA ANTE FENESTRAM TO THE ANNULAR LIGAMENT OF THE STAPES

From the accompanying figures it will be noted that one end of the middle part of the fissula comes to lie in close relation to the annular ligament of the stapes foot-plate. In most cases the tissue of the stapes ligament is continuous with the tissue of the fissula. The connective tissue cells of the annular ligament are arranged in a radial direction, or the long axes of the fibroblasts lie at right angles to and stretch across the stapes joint. These cells retain this same direction as they continue into the fissula, which communicates at a right angle with the stapes joint. This is well shown in figures 8 and 28. In a small percentage of cases the communication with the stapes joint does not occur. This is shown in figure 12. In figure 20 the communication is poorly formed.

No attempt is made in this paper to explain this communication of the fissula with the stapes joint; it is intended only to present this relationship as an anatomic fact. However, it may be well to bear this relationship in mind in studying otosclerosis, since it usually occurs in this region and often causes ankylosis of the stapes.

DEVELOPMENT OF THE CAPSULE IN THE REGION OF THE FISSULA

It has already been stated that the otic capsule changes from precartilage to cartilage about from the eighth to tenth week of intrauterine life. Ossification starts at certain designated areas at about 16 weeks. By 24 weeks the capsule is well ossified, except certain areas in the region of the canals. (For the complete history of ossification see my previous articles.[13])

The portion of the capsule surrounding the fissula ante fenestram ossifies at about from 22 to 23 weeks. It is one of the last areas to ossify. The only areas which ossify later are in the canal region and a ring around the oval window. The structure of the newly ossified otic capsule around the fissula is shown in the 210 mm. fetus (figs. 13

13. Bast.[1, 12]

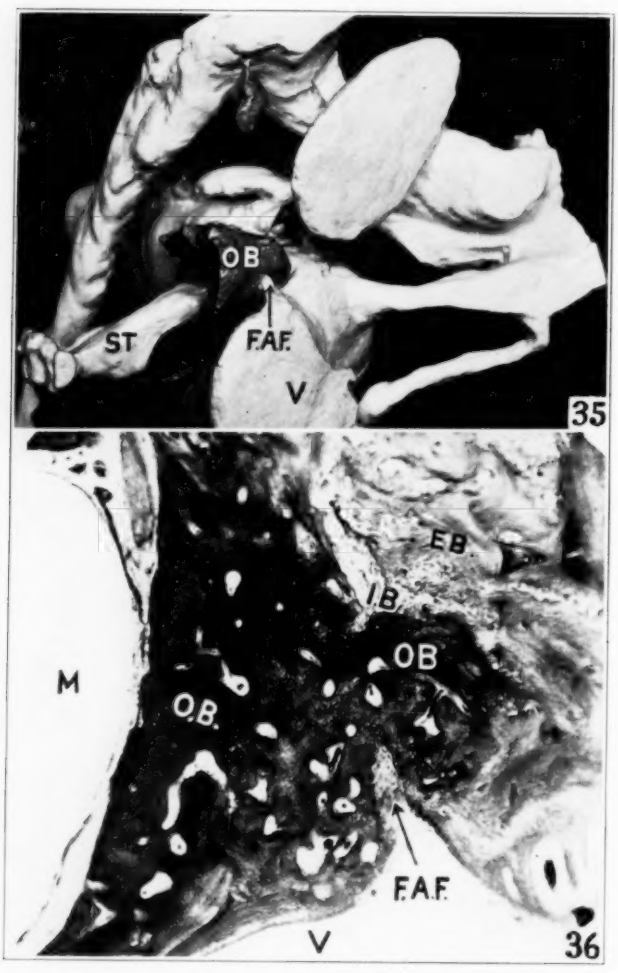

Fig. 35.—Model of part of the internal ear showing an otosclerotic area (*OB*). The area lies anterior to the stapes (*ST*) and caps over the vestibular end of the fissula ante fenestram (*F.A.F.*).

Fig. 36.—Section through the otosclerotic area shown in figure 35. The dark bone (*O.B.*) is otosclerotic bone. It surrounds the fissula ante fenestram (*F.A.F.*). The intrachondral bone (*I.B.*) is more resistant to the otosclerotic invasion than the endochondral bone (*E.B.*).

The serial sections from which the model was made (figure 35) and the photograph was taken (fig. 36) belong to Dr. J. Gordon Wilson, who loaned them to me for study.

to 16). The only bone formed at this time is intrachondral bone [1] and some perichondral bone (fig. 16). It is at this time that the peripheral portion of the tissue of the fissula changes to cartilage. Intrachondral bone (so-called cartilage islands) grows no more after once being formed, but endochondral bone forms around it in subsequent development. Figures 21 to 24, taken from a 305 mm. fetus, show the further endochondral ossification around the fissula. The dark-staining intrachondral bone is surrounded by the light areas of endochondral bone. It is this endochondral bone and its subsequent growth that complete the ossification. In a full-term fetus, as shown in figures 25 to 28, the bone marrow spaces are greatly reduced owing to the growth of the endochondral bone around the intrachondral bone. The formation of perichondral bone also goes on and accounts for the thickening of the wall of the capsule.

The completion of the ossification varies considerably in different fetuses, but the 210, 305 and 370 mm. fetuses show representative stages in the process. In the 290 mm. fetus shown in figures 17 to 20, the ossification is much further advanced and is physiologically more mature than that in the 305 mm. fetus. Either the 290 mm. fetus was a much older fetus than its size indicated, or else the ossification progressed much more rapidly than in other fetuses, for structurally the bone looks like that in a full-term fetus.

The otic capsule around the fissula, then, is not different from the otic capsule around the cochlea or vestibule, except that the cartilage lining the bone around the fissula does not ossify but remains throughout life.

COMMENT

A review of the literature reveals three interpretations regarding the fissula ante fenestram: 1. Mayer, Kosokabe and others regarded the fissula as a synchondrosis or a place where the two processes of chondrification of the vestibular and cochlear capsule meet but are separated by perichondrium. 2. Perozzi regarded the perichondrium as a place for growth, which thus permits the cochlea to describe its spiral. 3. Guggenheim regarded the fissula as a vestige of the canalis fenestrae ovalis of the frog and therefore as "predisposed to mesenchymal invasion."

The embryologic findings outlined in this paper do not suggest the first and second views. Certainly the tissue of the fissula is not of a simple perichondral type. While there is condensation of the tissue of the fissula where it borders the cartilage, the central part varies from a loose vascular reticular type to a loose periotic type.

The third view is arrived at, so far as can be ascertained, from Guggenheim's papers, through philosophical deduction. This interpretation may be correct. However, I have never found a fissula either

in the embryo or in the adult of any of the laboratory animals, from rats to monkeys, or in pigs and cows. Hyrtl claimed to have found something like the fissula in an antelope and a hyena. If the fissula is a rudimentary structure, it should be present at least in some of the intermediate animals between the frog and man.

The second point made by Guggenheim, that the fissula is a rudimentary structure and is predisposed to mesenchymal invasion, is based on the fact that otosclerosis usually attacks the otic capsule in the region of the fissula. This concept is open to question. While it is a fact that otosclerosis is very apt to start in the region of the fissula, it does not as a rule attack the tissue of the fissula or the supposedly more primitive intrachondral bone (so-called cartilage islands) first, but rather the bone surrounding these. I have had occasion to examine a number of Dr. J. G. Wilson's preparations of otic capsules with pathologic changes in the bone; the pathologic process had eroded enlarged areas of endochondral bone, and the so-called cartilage islands were slowly effected and were protruding into the excavated area. This is in part shown in figure 36, in which a process of the intrachondral bone (*I.B.*) is seen projecting into the otosclerotic area. In one of Dr. Wilson's specimens of otosclerosis in which the otosclerotic patch involved most of the capsule in the region of the fissula, the fissula near the middle ear was destroyed, but the vestibular end of the fissula was unchanged and extended a considerable way into the otosclerotic area. This is pictured in figures 35 and 36. It appears that the perichondral bone and the endochondral bone are most predisposed to pathologic change, whereas the fissula and the intrachondral bone are more resistant. This observed pathologic sequence is contrary to what one would deduce from philosophic reasoning and shows that abstract reasoning will not necessarily reveal scientific fact.

CONCLUSION

While I do not intend entirely to discredit the former views regarding the fissula, I wish merely to present that my observations on fifty-five human fetuses show that the vestibular end of the fissula ante fenestram is an outpouching from and develops in a manner similar to the periotic tissue. As this developing fissula pushes through the capsule toward the middle ear its development is somewhat altered and is speeded up by the entrance of blood vessels from the side of the capsule near the middle ear. Whether the blood vessels within the fissula of the fetus throw any light on the function of the fissula cannot be asserted until it has been established whether these vessels remain throughout adult life.

SARCOMA OF THE LARYNX

FREDERICK A. FIGI, M.D.
ROCHESTER, MINN.

Sarcoma of the larynx, once regarded as of not uncommon occurrence, has come to be regarded as rare. This is because pathologists have changed their interpretation of histologic observations and not because there has been a decrease in the incidence of the disease. Many neoplasms of the larynx formerly thought to have originated from supporting tissue elements have come to be considered by laryngologists and pathologists as of epithelial origin. The small number of proved laryngeal sarcomas, or the complete lack of them, observed by those reporting the largest series of cases of malignant tumors of the larynx would seem to be the best criterion as to the rarity of the condition.

In the Mayo Clinic 713 cases of carcinoma of the larynx have been encountered since 1910. In this same period 4 cases of sarcoma of the structure have been seen; these form the basis of this paper.

Various statements in the literature convey widely divergent views regarding the incidence of sarcoma of the larynx. Carcinoma of the larynx, as well as of other portions of the body, is of much more common occurrence than sarcoma. The ratio of sarcomas to carcinomas has been stated by different observers as ranging from 1:11 to 1:25. Sendziak [1] found 56 sarcomas among 535 cases of malignant disease of the larynx. Ewing [2] stated: "Sarcomas form 11 per cent of malignant laryngeal growths (Molinii)." He added, however, "It is probable that many cases recorded as sarcoma are of epithelial origin." On the other hand, Bosworth [3] in his treatise on "Diseases of the Nose and Throat," published in 1892, stated that sarcoma in the larynx is to be regarded as of exceedingly rare occurrence. He reviewed 48 cases reported in the literature. Two of these were excluded as they proved subsequently to be cases of carcinoma. He added a single case of his own. Bergeat,[4]

From the Section on Laryngology, Oral and Plastic Surgery, the Mayo Clinic.
Read before the American Laryngological, Rhinological and Otological Society, Chicago, June 10, 1933.

1. Sendziak, quoted by Wright, Jonathan, and Smith, Harmon: Diseases of the Nose and Throat, Philadelphia, Lea & Febiger, 1914, p. 513.

2. Ewing, James: Neoplastic Diseases, ed. 2, Philadelphia, W. B. Saunders Company, 1922, p. 856.

3. Bosworth, F. H.: Sarcoma of the Larynx, in Diseases of the Nose and Throat, New York, William Wood & Company, 1892, vol. 2, p. 742.

4. Bergeat, Hugo: Das Sarkom des Kehlkopfes und der Luftröhre, Monatschr. f. Ohrenh. **29**:277, 1895; **31**:193, 1897.

in reviewing the literature up to 1897, found reports of 99 cases of sarcoma of the larynx. Intensive study of these as well as of many other reported cases of laryngeal sarcoma at the present time is quite unsatisfactory, because of the uncertainty of their histologic classification. Of 10 cases of primary sarcoma in Bergeat's group in which microscopic examinations were made the sarcoma was reported as small or round cell in 5 cases, as spindle cell in 3, as of a papillary type in 1 and as of an alveolar type in 1. In the light of the present conception of histologic pathology, particularly as it pertains to the larynx, one is inclined to believe that the small or round cell, papillary and alveolar lesions are more likely to be of epithelial origin. Undoubtedly a careful recheck of the histologic changes in a number of these cases, were this possible, would result in many laryngeal neoplasms now recorded as sarcomas being reclassified as carcinomas. In Jackson's [5] series of 643 neoplasms of the larynx, not a true sarcoma was encountered. However, in a number of specimens removed for biopsy the lesions histologically closely resembled sarcoma, but further examination showed that they were not true sarcoma. Thomson and Colledge,[6] in a wide experience, have seen a single sarcoma of the larynx.

Sarcoma of the larynx has been observed much more frequently among male than among female subjects. Bosworth's 47 cases occurred in 34 men and 13 women. The youngest patient in his series was a woman aged 19, observed by Caselli.[7] The oldest patients were those observed by Lange [7] and Elsberg,[7] respectively; each was 74 years of age. Of the remaining patients, 4 were in the third decade, 7 in the fourth, 9 in the fifth, 11 in the sixth and 6 in the seventh. It is generally thought that sarcoma is encountered more often in early than in late adult life, and that it is relatively more common than carcinoma in young adults. As regards malignant disease of the larynx, this generalization is erroneous. Most patients with laryngeal sarcomas are more than 40 years of age, which is likewise true of those with laryngeal carcinoma. The 4 patients in my series were all more than 60 years of age; 2 of them were more than 70. All were men. On the other hand, several patients in the second decade with carcinoma of the larynx have been encountered in the clinic, and the disease has not been particularly unusual in patients between the ages of 30 and 40.

The etiology of sarcoma of the larynx is as obscure as that of other malignant lesions. The probable relationship of various forms of

5. Jackson, Chevalier, and Coates, G. M.: The Nose, Throat and Ear and Their Diseases, Philadelphia, W. B. Saunders Company, 1929, p. 991.

6. Thomson, St. Clair, and Colledge, Lionel: Cancer of the Larynx, London, George Routledge & Sons, Ltd., and Kegan Paul, Trench, Trubner & Co., Ltd., 1930, p. 16.

7. Quoted by Bosworth.[3]

chronic irritation has been assumed by some writers. The initial symptom, hoarseness, in a case presented here dated from a period of vocal strain incident to public speaking. In another case the same primary symptom developed during the course of an acute infection of the upper part of the respiratory tract and progressed up to the time of discovery of the laryngeal tumor a month later. The relationship of vocal strain and local infection to the onset of the malignant process is, of course, problematic and may well be considered only a coincidence. This sequence has also frequently been noted in cases of carcinoma of the larynx. It might, however, be more accurately stated that the slowly

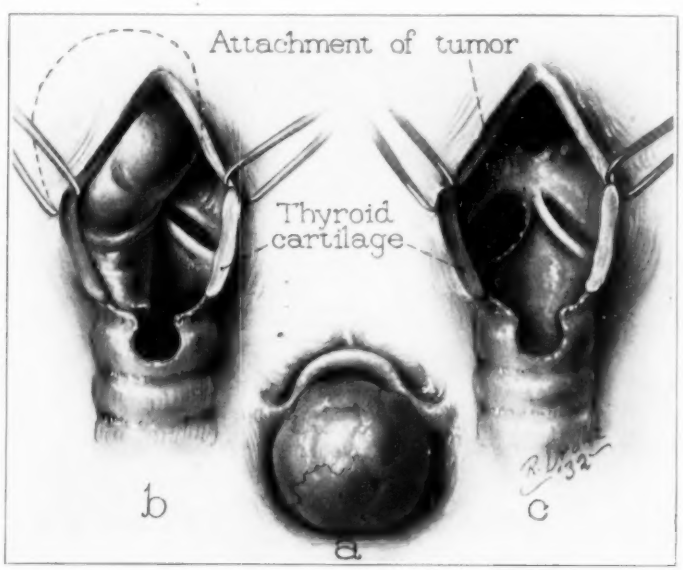

Fig. 1 (case 4).—Fibrosarcoma of the larynx: *a*, tumor presenting in the hypopharynx, as seen with the laryngeal mirror; *b*, tumor as viewed through the laryngofissure; *c*, larynx after removal of the tumor; the site of attachment is shown.

developing symptoms in these cases became noticeable as the result of the acute infection of the respiratory tract or of trauma from abuse of the voice.

Sarcoma may originate in any portion of the larynx, but like carcinoma of this organ it is most often primary in the vocal cords. In 3 of the cases of my series the growth arose in this situation; in the fourth case it originated in the subglottic region, which has been stated by some writers to be the most common site. Often the tumor is so extensive at the time the patient first comes under observation that it is impossible to determine from clinical examination the area from which it springs; this was true of 2 cases of my series. However, in 1 case,

in which the tumor was in the subglottic region, the presence of a slough necessitated an emergency tracheotomy; the slough separated in the course of two weeks, revealing the attachment of the neoplasm below the anterior commissure. In another case it was impossible to determine either the site or the extent of the attachment until exploration through a thyrotomy opening was carried out.

As a rule the neoplasms are pedunculated and they may be lobulated. Ulceration does not ordinarily develop, which is in contrast with the early ulceration commonly present in carcinoma of the larynx. The smooth mucous membrane covering the tumor may be coated with

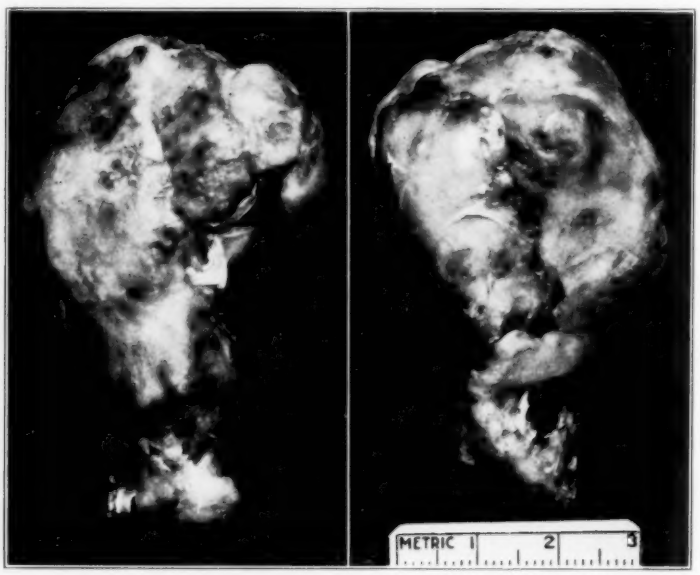

Fig. 2.—Fibrosarcoma. Its density is evidenced by retention of the conformation of the interior of the larynx.

tenacious mucus, which gives the appearance of superficial ulceration or erosion. When the mucus is wiped away, the surface of the tumor does not bleed unless it is traumatized. Even though the growth extends entirely across the laryngeal lumen, so that its free surface rubs firmly against the normal mucous membrane for a prolonged period, ulceration may not occur. In 3 of the cases presented the tumor was pedunculated; in the fourth the attachment was sessile. In 1 case the growth completely filled the larynx and the laryngopharynx from a point a little above the tip of the epiglottis to the level of the tracheotomy opening made through the first tracheal ring. The tumor, in fact, formed a complete cast of the interior of the larynx. A curved concavity was also present on its inferior surface, the result of contact with the tracheal

cannula. Although the tumor was definitely known to have been present and approximately of this size for five months, there was no ulceration at any point.

Sarcoma of the larynx is usually more definitely localized than carcinoma in the same situation, and it manifests decidedly less tendency to infiltrate. Although the visible tumor of the former type is often much larger than that of many carcinomas of the larynx, the area of infiltration of the laryngeal structures is not nearly so extensive. On this account, even large tumors can often be removed through laryngofissure, whereas a carcinoma of apparently the same extent would

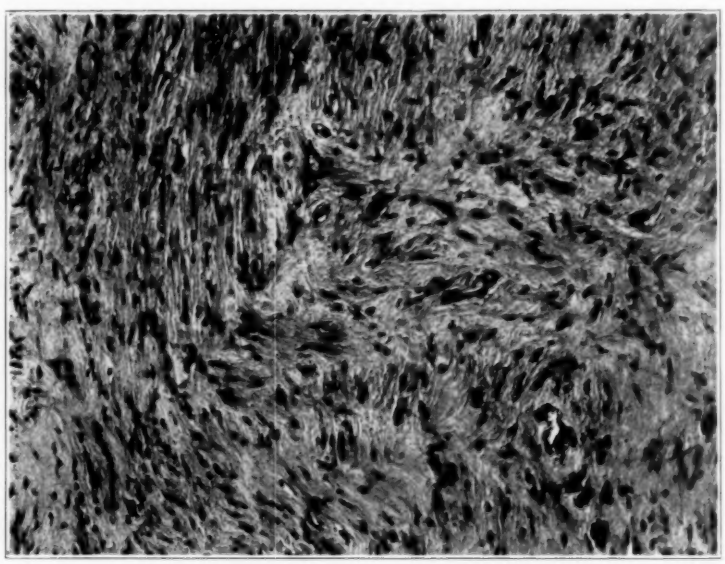

Fig. 3 (case 4).—Fibrosarcoma, graded 1; × 125.

necessitate laryngectomy. Metastasis also is longer delayed in cases of sarcoma, so that these growths remain operable considerably later than do epithelial tumors of the same degree of activity. Among the 47 cases of sarcoma of the larynx analyzed by Bosworth, cervical metastasis was present in only 6. In 1 of these there was generalized metastasis to the lungs, liver and brain, which resulted fatally three months after primary invasion of the larynx.[7] Butlin's [8] explanation of the tendency of laryngeal sarcoma to metastasize late, if at all, seems plausible. He stated: "The sarcomas of these parts arise by proliferation of the cellular elements of the solid structures of the connective tissues. As the cells proliferate, the solid structures gradually swell, and the

8. Butlin, H. T.: On Malignant Disease (Sarcoma and Carcinoma) of the Larynx, London, J. & A. Churchill, 1883, p. 14.

lymphatic vessels suffer a diminution in their caliber which proceeds to their complete obliteration and renders them incapable of transmitting the infecting material of the tumor." Slobodnik[9] noted a definite periodicity in the growth of a tumor of this type, as regards both the entire tumor and its various lobules. Although the tumor in his case had remained practically stationary for about two years and did not appreciably change the size of the lumen of the glottis for a year, subsequently during the course of three weeks it grew rapidly. The same variation in the rate of growth of different lobules was likewise observed.

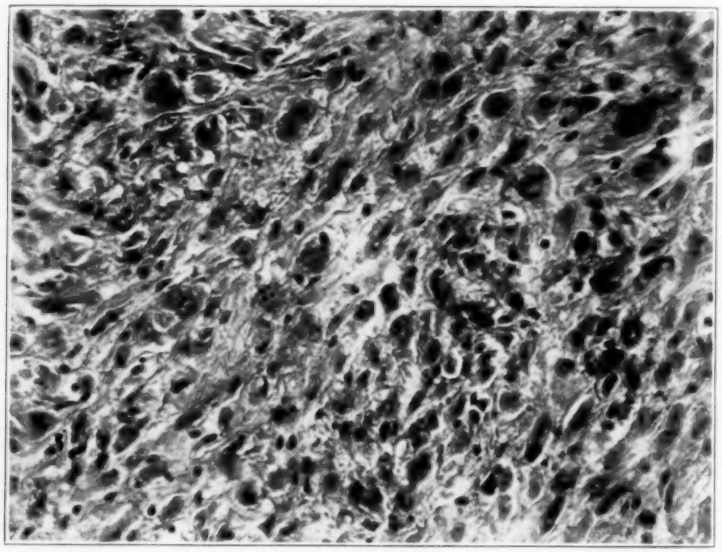

Fig. 4 (case 1).—Fibrosarcoma, graded 4; × 160.

SYMPTOMS

The early symptoms of sarcoma of the larynx are due to mechanical interference with function, and depend on the size and situation of the growth. They are, as a rule, insidious in onset and vary in rate of progression with the activity of the tumor. Hoarseness is usually the first symptom noted, and develops early, except in cases in which the neoplasm is situated entirely below or above the glottis. It may be present for months and progress to complete aphonia before other symptoms appear. Dyspnea invariably follows in the course of time, unless the tumor is removed in its early stages. Often the respiratory difficulty progresses rapidly, and emergency tracheotomy may be

9. Slobodnik, M.: Zur Frage der Kehlkopfsarkome, Ztschr. f. Hals-, Nasen- u. Ohrenh. **19**:505, 1928.

required. The trachea was opened as an emergency procedure in 2 of my cases. Dysphagia is not likely to be a prominent symptom unless the growth springs from the epiglottis or another portion of the superior laryngeal border, or unless it becomes large and protrudes into the hypopharynx. In 1 of my cases, in which a large tumor filled the laryngopharynx, dysphagia was an outstanding symptom. Difficulty in swallowing any type of food was pronounced, and liquids and particles of solid food were frequently aspirated, thus inducing distressingly severe paroxysms of coughing. It became necessary to insert a Rehfuss feeding tube. The increased mucoid secretion within the larynx due to

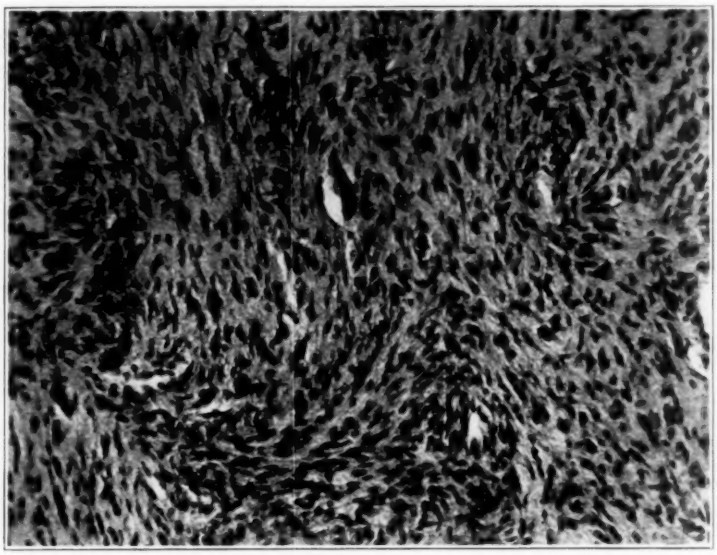

Fig. 5 (case 2).—Fibromyxosarcoma, graded 2; × 200.

the tumor may also produce severe coughing; at times this is one of the most troublesome complaints. Pain or discomfort in the throat is not a prominent feature, probably because of lack of ulceration and associated infection, together with the slight tendency toward infiltration.

Neither the symptoms nor the physical findings are sufficiently characteristic in cases of sarcoma of the larynx to permit a clinical diagnosis. At times the tumor strikingly simulates a benign growth; at others, a highly malignant carcinoma. The absence of cervical glandular enlargement in the presence of an extensive, obviously malignant laryngeal neoplasm is suggestive. A rapidly growing, pedunculated tumor presenting a smooth, nonulcerated but possibly eroded surface covered with tenacious, mucopurulent secretion also should be viewed with suspicion. A positive diagnosis, however, is possible only with careful microscopic

study of the tumor itself, and such a diagnosis is acceptable only when made by a competent and experienced pathologist.

TREATMENT

The treatment of sarcoma of the larynx depends on its size, situation and activity. Since many of these tumors are pedunculated, show less tendency to infiltrate the laryngeal structures and metastasize later than do carcinomas of the larynx, they may remain operable for a considerably longer period. Many of them are quite inactive and in an early stage may be removed readily by means of direct, indirect or suspension

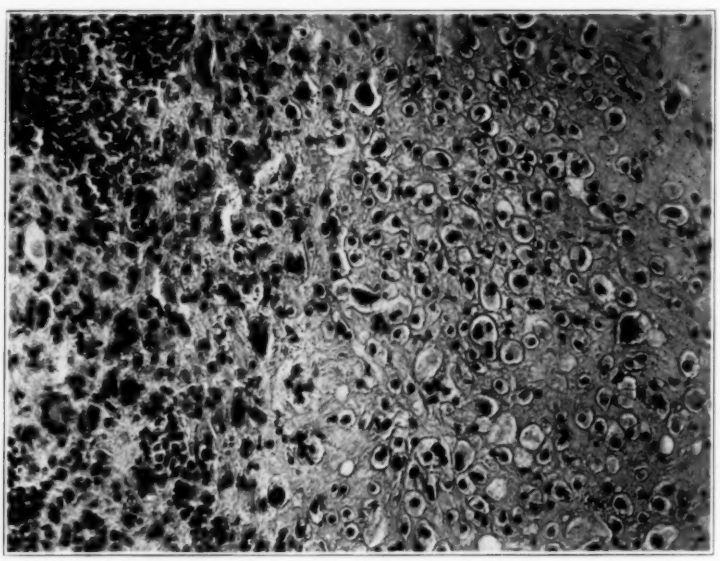

Fig. 6 (case 3).—Fibrochondrosarcoma, graded 3; × 125.

laryngoscopy. If such removal is followed by electrocoagulation of the attachment of the tumor, the prognosis will be good in many cases. If the tumor is too extensive to remove in this manner, laryngofissure or laryngectomy may be necessary. The first lasting success on record following laryngectomy was achieved by Bottini [10] of Turin, in 1876, in a case of mixed round and spindle cell sarcoma of the larynx. The patient was known to be in good health more than three years later.

Thyrotomy is especially useful in the treatment of sarcoma of the larynx, since many of the growths are pedunculated, and there is little tendency for them to cross either commissure to involve both sides of the larynx. Even though the tumor may be extremely large and completely

10. Bottini, quoted by Mackenzie, Morrell: Diseases of the Throat and Nose, Philadelphia, Presley Blakiston, 1880, vol. 1, p. 346.

fill the larynx and upper part of the trachea, it may on exploration be found to spring from a comparatively small pedicle with a well localized attachment, so that removal through laryngofissure can be carried out readily. In general, it would seem that the most conservative type of procedure permitting removal of the growth should first be carried out in cases of the more inactive types of neoplasm, as the records of cases of this type show that even when recurrence took place there was not sufficient activation to prevent removal by a somewhat more radical operation later, and the prognosis was apparently little affected. In dealing with carcinoma of the larynx, on the other hand, ultraconservatism is entirely inadvisable, since in many cases it has definitely jeopardized the patient's chances of getting well.

In 2 of the cases in this series sarcoma was removed with forceps by indirect laryngoscopy. In one of these cases radon points of small value were implanted into the base of the pedicle subsequently; in the other case, electrocoagulation of the base was carried out. In the latter case a similar-appearing tumor had been removed from the same situation two years previously. Microscopic examination at that time had shown inflammatory tissue only, whereas fibrochondrosarcoma graded 3 was reported at the time of the second removal. Recurrence did not take place in either case. In the third case a benign-appearing fibrous tumor attached to the anterior portion of the right vocal cord was removed by indirect laryngoscopy. Although this appeared to be inflammatory tissue on microscopic examination, a rapid recurrence of the growth necessitated an emergency tracheotomy four months later. At that time a large, smooth tumor with a slightly eroded surface filled the larynx almost to the level of the tip of the epiglottis. As the patient's general condition was such as to contraindicate any type of operation on the larynx, radium was applied externally, and the patient was kept under observation. Six months later there was definite increase in the size of the mass, but the rate of growth had been much slower than during the preceding four months. Since the tumor now filled the entire larynx and lower portion of the hypopharynx, as well as the subglottic space as far down as the tracheal cannula, it was impossible to determine either the extent of the attachment of the mass or whether there was appreciable infiltration of the larynx itself. Exploration through laryngofissure was accordingly carried out, and the tumor was found to be attached by a comparatively small pedicle to the floor of the right ventricle and the adjacent upper surface of the vocal cord. Following removal of the tumor, diathermy was applied to the base of the pedicle. In the fourth case an emergency tracheotomy was rendered necessary by recent rapid enlargement of a subglottic tumor, the result of acute inflammatory reaction, accompanied by considerable

sloughing of the mass. Subsequently, the growth was explored through a thyrotomy opening and almost complete laryngectomy was performed in order to effect its removal.

Although fibrosarcomas comprise the majority of malignant mesoblastic laryngeal tumors, almost every variety of sarcoma has been reported. The less frequently encountered types include chondrosarcoma, myxosarcoma and rhabdomyosarcoma as well as combinations of these different forms. Even those originating from the same tissue elements may vary greatly in their rate of growth or in their degree of malignancy, ranging from extremely inactive to fulminating types of growth. Two of the tumors in my series were fibrosarcomas; 1 was a fibromyxosarcoma and 1 a fibrochondrosarcoma. Malignancy was graded respectively 1, 2, 3 and 4. It may be noted that the most inactive tumor in the group histologically was the largest.

PROGNOSIS

The prognosis in sarcoma of the larynx, as in carcinoma of this organ, depends on the extent of the growth, its activity and the thoroughness with which it is removed. In general, the outlook is somewhat better in the former condition than in the latter, since a higher percentage of sarcomas are pedunculated and there is less tendency for infiltration and metastasis. In the group of 47 cases studied by Bosworth the average duration of life after the onset of symptoms was a little more than nineteen months. It should be remembered, however, that all of the patients in whom these cases occurred were treated prior to 1892. With the refinements in technic, the improved instruments and the increased knowledge of pathologic changes in the larynx, the prognosis in this condition as well as in carcinoma of the larynx has greatly improved. Of the 4 patients whose cases are reported here, only 1 is known to be dead. This patient died of influenza, probably free from recurrence, sixteen and a half months following partial laryngectomy for removal of fibrosarcoma graded 4. The symptoms had existed for more than a year prior to operation; thus the duration of life after the onset of symptoms was more than twenty-eight and a half months. The remaining three patients have now lived eight years, seven years and two months, and two years, respectively, since symptoms were first noted. All were free from symptoms when last heard from, eighty-nine months, forty-three months and six months, respectively, following operation.

REPORT OF CASES

Case 1.—A man, aged 61, was brought to the Mayo Clinic on Nov. 20, 1917, because of extreme dyspnea. A year previously he had consulted a physician elsewhere on account of a growth in his larynx. Surgical procedures were not

considered advisable, and medical treatment was prescribed. Following this he had been well until a month prior to admission to the clinic, when he became hoarse and noticed some shortness of breath. Both of these symptoms had increased in severity, and about three weeks later local treatment was applied to the larynx because of the shortness of breath. Tracheotomy was advised, but was refused by the patient.

The patient was admitted directly to the hospital, where laryngeal examination showed a sloughing mass just below the glottis, producing almost complete obstruction. An emergency tracheotomy was done. Within the course of two weeks the slough came away, revealing a tumor attached to the anterior wall of the larynx and upper portion of the trachea. Biopsy showed the tumor to be highly malignant. The voice at that time was quite satisfactory.

On December 7, the growth was explored through an anterior median line incision; it was found to be so extensive that almost complete laryngectomy was necessary. Subsequent microscopic examination disclosed fibrosarcoma, graded 4. The patient died of influenzal pneumonia sixteen and a half months later, apparently without recurrence of the fibrosarcoma.

Case 2.—A man, aged 69, came to the clinic on Sept. 14, 1925, because of hoarseness of six months' duration. The onset had been sudden, and the condition remained unchanged up to the time of admission. He had no other complaint, aside from the presence of tenacious mucus in the throat, and had received no treatment. Laryngeal examination disclosed what appeared to be an epithelioma involving the anterior half of the left vocal cord. There was no limitation of motion, and the remainder of the larynx was normal. General physical examination revealed rather marked arteriosclerosis with myocardial degeneration and large varicose veins of both lower extremities. A roentgenogram of the thorax gave evidence of dilatation of the aorta with possible aneurysm. Tissue removed from the larynx for biopsy was reported to be fibromyxosarcoma, graded 2. Because of the patient's general physical condition and the low grade malignancy of the lesion, radium therapy was advised. On October 3, five 0.5 millicurie bare glass radium emanation seeds were implanted in the tumor of the left vocal cord, and three days later a total of 7,000 mg. hours of radium was given with 2 mm. of lead screening and at a distance of 2.5 cm. externally over the larynx and regional lymphatic vessels. The patient was reexamined at intervals of from one to six months for three years subsequently. There has been no recurrence of the neoplasm. On several occasions granulomatous nodules were present. These were removed with forceps and the base cauterized with diathermy. In a recent communication the patient stated that there has been no return of his trouble.

Case 3.—A man, aged 73, came to the clinic on Oct. 25, 1927, because of intermittent hoarseness of two years' duration. At the time of examination this had been present continuously for a period of one month. Local applications to the larynx had been made by the patient's physician on several occasions.

Examination disclosed a pedunculated tumor attached to the anterior third of the left vocal cord. The tumor was removed by means of indirect laryngoscopy. Grossly it appeared to be polypoid and microscopically, inflammatory.

Twenty-one months later the patient returned on account of a recurrence of hoarseness of three months' duration. A polypoid tumor, about 1 cm. in diameter, appeared to be springing from the anterior commissure. This was removed by indirect laryngoscopy and microscopically proved to be a fibrochondrosarcoma, graded 3. Its attachment within the larynx was thoroughly coagulated with diathermy. There has been no recurrence of the tumor three years and seven months following operation.

CASE 4.—A man, aged 71, came to the clinic on Sept. 10, 1931, because of hoarseness, which had first appeared about seven months previously after he had been doing a good deal of public speaking. There had been no infection of the respiratory tract. Hoarseness had increased up to the time of examination; he was practically aphonic. He had experienced no pain or dysphagia and was gaining weight. His general health had been good.

The patient appeared to be in exceptionally good general physical condition for one of his years. Laryngeal examination disclosed the presence of a nonulcerated tumor involving the anterior two thirds of the right vocal cord; it did not appear to be malignant. Laboratory studies, including a urinalysis, blood count, roentgenogram of the thorax and serologic test for syphilis, gave negative results. Tissue was accordingly removed from the tumor for biopsy on two occasions. The procedure was not entirely satisfactory, since the tumor was covered with a tough fibrous membrane which the laryngeal forceps penetrated with difficulty. There seemed also to be calcareous or cartilaginous material underlying the capsule in areas. Microscopically the tissue appeared to be inflammatory.

The patient was advised that a definite diagnosis could not be made without exploratory thyrotomy, but as the condition appeared to be benign, this was not urged. Besides, the patient's chief complaint was hoarseness, and it was impossible to foretell how much improvement might be anticipated. He accordingly returned home with instructions to come back for observation in two or three months should the condition progress.

Four months later he was brought directly to the hospital a week after having had an emergency tracheotomy done at his home. He was extremely ill, had lost considerable weight, had an elevation of temperature to 103 F. and was coughing a good deal. There was definite clinical evidence of bronchopneumonia. He had a discharging sinus over the left hip where an abscess had been incised recently. Roentgenograms of the pelvis were negative, but those of the thorax disclosed marked infiltration on the right side with thickening and retraction of the pleura. Further roentgenograms taken at intervals during the next few weeks showed what at first appeared to be multiple pulmonary abscesses and later extensive tuberculosis. Leukocytes ranged from 6,800 to 20,800 in each cubic millimeter of blood. Repeated examinations of sputum were negative for bacilli of tuberculosis, and inoculation of guinea-pigs yielded negative results.

Because of the patient's acute illness no attempt was made to check on the laryngeal condition for several weeks. Indirect laryngeal examination then showed a rounded, superficially ulcerated tumor completely filling the superior laryngeal aperture. This appeared clinically to be malignant, but as the patient was not at any time in condition to permit surgical procedures on the larynx a biopsy was not made. Radium was applied externally; a total of 12,700 mg. hours was given on one occasion and 10,600 mg. hours six weeks later. Following the latter treatment and ninety-one days after admission to the hospital, the patient returned home. At that time roentgenograms of the thorax gave definite evidence of bronchiectasis, and he had the severe cough and abundant sputum characteristic of this condition. His general condition was much improved, however, and he had almost regained his normal weight.

The patient was advised to return after two or three months for further observation. During this period he was fitted with an artificial voice box from which he derived considerable pleasure. On his return after about three months his general condition appeared to be satisfactory. He had been working all the time and had gained some weight, in spite of the fact that it had been very difficult for him to swallow during the last few weeks. His cough had practically ceased.

The tumor was somewhat larger, but had apparently not changed otherwise. Following cocainization the epiglottis was retracted and the tumor manipulated with an applicator. It was found to have a smooth surface, the ulceration having healed, and was quite hard, suggesting a chondroma. Biopsy was attempted, but this was again unsatisfactory because of the tough capsule covering the mass. The tracheotomy tube was removed, and the tumor was found to be resting directly on it. Roentgenograms showed a soft tissue tumor filling the interior of the larynx, and some destruction of the cartilage on the right lateral wall and anteriorly. Exploration through a laryngofissure was advised, and this was done under regional anesthesia on June 30, 1932. On dividing the thyroid cartilage a smooth, non-ulcerated tumor was found completely filling the lumen of the larynx; it extended from the level of the tip of the epiglottis above to the tracheotomy opening below, the lower surface resting directly on the tracheal tube and bearing its imprint, whereas the portion of tumor above formed a perfect cast of the interior of the larynx, showing all its irregularities on its surface. It arose from a comparatively small pedicle attached to the floor of the right ventricle and the superior surface of the right vocal cord. The pedicle was cut across and its base thoroughly cauterized. Microscopically, the tumor was reported as fibrosarcoma, graded 1. It measured 6.5 by 4 by 3 cm. The postoperative course was stormy and convalescence protracted. However, the patient returned home in excellent general condition approximately two months following operation. At that time the tracheal wound and the wound within the larynx were practically healed, and the voice was quite normal. In view of the low grade character of the tumor the prognosis should be excellent.

SPONTANEOUS CEREBROSPINAL OTORRHEA

ORAM R. KLINE, M.D.
CAMDEN, N. J.

The spontaneous discharge of cerebrospinal fluid from the nose was first positively established as a pathologic possibility by St. Clair Thomson [1] in 1899. Since the publication of his monograph, reports of a considerable number of cases have appeared in the literature, although it is still regarded as an exceedingly infrequent condition.

It has long been known that cerebrospinal fluid may escape from the ear after fractures of the base of the skull or following operations during which the inner ear or subdural space has been opened, but the literature dealing with spontaneous cerebrospinal otorrhea is apparently meager.

Canfield,[2] in 1913, reported a case of escape of cerebrospinal fluid and pus from the ear with no history of trauma, but the condition was preceded by pain in the ear for six weeks and impaired health for six months. The report of the autopsy was as follows:

> A plastic basal meningitis. The apex of the right temporal bone was occupied by a very large pneumatic cell containing cerebrospinal fluid and pus. The perforation through the wall of this cell had permitted the entrance of infection to the subdural space and the escape of cerebrospinal fluid externally into the pneumatic structure of the temporal bone, thence to the middle ear and external canal.

Canfield in the same paper reported certain findings during an operation on the labyrinth which are of interest in connection with the case that I am presenting. Following is a quotation from his observations:

> The cerebellum was uncovered and an attempt made to open the labyrinth from behind. On account of the escape of cerebrospinal fluid from a small circular opening in the dura, which was probably a large perilymphatic duct opening atypically into the subdural space, this stage of the operation was not permitted.

Although the hole in the dura was obliterated by a suture, the postoperative flow of cerebrospinal fluid was profuse and persistent until a

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Read before the Section on Otolaryngology of the College of Physicians, Philadelphia, Feb. 15, 1933.

1. Thomson, St. Clair: The Cerebrospinal Fluid; Its Spontaneous Escape from the Nose, London, Cassell & Co., 1899.

2. Canfield, R. B.: Some Conditions Associated with the Loss of Cerebrospinal Fluid, Ann. Otol., Rhin. & Laryng. **22**:604, 1913.

graft from a dog's dura was tamponed over the opening. After this procedure the patient made a complete recovery.

Roth,[3] in 1931, stated that he was unable to find in the literature records of any aural discharge of cerebrospinal fluid other than that following injuries of the head with fracture at the base of the skull. He then submitted what he termed the first report of a spontaneous cerebrospinal otorrhea. His patient was a man, aged 53, who had complained of a discharge from the left ear since childhood. About six years before examination two operations were performed on the left mastoid. The discharge became nonfetid after the first mastoidectomy, but attacks of vertigo persisted until after the second operation. The patient had been well since that time, although he continued to complain of a discharge from the ear. Examination of the external auditory canal revealed a watery discharge arising from the middle ear. The discharge was not profuse; it was necessary to remove it from the canal with a pipet to obtain enough for examination. The left labyrinth was less sensitive to stimuli than the right, and the response to the fistula test was not constant.

The history and findings certainly suggest that the labyrinth was wounded during one of the operations on the mastoid. Since this contingency cannot be ruled out, it seems that the cerebrospinal otorrhea in this case should be classified as postoperative.

Although the literature has been carefully searched, these are the only case records I have found that relate to a condition which seems to resemble the unusual one that I am about to describe. It is hoped that this paper will serve to bring forth other reports of the occurrence of spontaneous cerebrospinal otorrhea, either unpublished ones or reports recorded in the literature which I failed to find.

REPORT OF CASE

History.—K. W., a man, aged 54, came to me on Dec. 30, 1932, complaining of a watery discharge from the right ear. He stated that he had been in good health except for a slight cold in the head the preceding week, during which time there had been no fever, earache, headache or vomiting. About three hours before coming to my office he stooped to pick up an object from the floor, and suddenly felt warm fluid run from his right ear. The discharge continued to appear, requiring almost constant cleansing with his handkerchief to prevent dripping from the ear. Careful questioning failed to bring out any reference to other symptoms of illness.

He did not recall ever having had an earache or discharge from the ear, although he had always been slightly deaf on this side. Later, however, a history of an abscess in the right ear complicated by erysipelas at 9 months of age was obtained from the patient's mother, who thought that the discharge had not

3. Roth, Emanuel: The Discharge of Cerebrospinal Fluid from the External Auditory Canal, Arch. Otolaryng. **13**:439 (March) 1931.

persisted for a prolonged period. Typhoid fever in boyhood and rheumatic fever at 30 years of age were the only prolonged illnesses recalled. Otherwise he had always been healthy with the exception of occasional so-called "bilious" attacks to which he had been subject as long as he could remember. These attacks consisted of a chill and headache with vomiting followed by fever; if a laxative was promptly given, he was well in twenty-four hours. Another point of possible interest is that his family had noticed some impairment of his memory during the past two months. He further stated that during the past year his life insurance rate had been increased on account of varicose veins, but that he had just been given a regular rating following a recent reexamination. This was accepted as evidence that his general health was apparently good immediately prior to his present illness.

Examination.—The temperature was 98 F., and the pulse rate, 72. The nose and throat were normal with the exception of some injection of the nasal mucosa and the presence of a moderate amount of postnasal mucoid discharge. The right external auditory canal presented a clear watery discharge which was so profuse that it was dropping from the lobe of the ear. An attempt to dry the canal with cotton-wound applicators precipitated coughing, which immediately caused an increase in the flow of fluid. I now felt reasonably certain that the discharge was cerebrospinal fluid, and collected about 3 cc. in a test tube for examination. The laboratory reported it to be a clear fluid responding to all tests in a manner characteristic of cerebrospinal fluid. Detailed functional hearing tests were not made, but the whispered voice was readily heard by the affected ear. This finding excluded any gross loss of hearing. Examination of the inferior bony wall of the auditory canal revealed two exostoses which reduced the natural lumen approximately 50 per cent. Beyond the exostoses a gray area could be seen which resembled the drum membrane, although no landmarks were visible. In this region the clear fluid, as rapidly as it was wiped away, reappeared without pulsation, but the point of entrance into the canal was not identified at this time.

Probable Cause of the Cerebrospinal Otorrhea.—What pathologic condition could account for the spontaneous escape of cerebrospinal fluid from the external auditory canal without apparent symptoms of disease? The history of severe infantile otitis media may be of significance. Possibly there was erosion of bone and dura at that time so that only a thin membrane of scar tissue remained to separate the middle ear from the subdural space. But, granting this, why should it rupture after fifty-four years without apparent cause?

Dr. Becker, the neurologic consultant, suggested the possibility of syringomyelia. There are usually other neurologic symptoms to support this diagnosis; however, a case in his experience had presented cerebrospinal rhinorrhea as the first symptom. He also suggested the possibility of a glioma, although he stated that there were no findings to sustain such a conclusion.

Subsequent Course of Events.—The patient was put to bed on a light diet with the head and shoulders somewhat elevated, and was instructed to do nothing to the ear. During the following two days, Saturday and Sunday, there was apparently no change in his condition, but on Monday the discharge was not so profuse. Tuesday the discharge became progressively less and ceased late in the afternoon. Wednesday morning the ear was still dry, and the patient was in excellent spirits. He insisted that he had never felt better. No change was noted in his condition until about 2 p. m.; then he became nervous and restless. Soon thereafter he complained of headache, and at 3 p. m. he had a severe chill accompanied by nausea but no vomiting. Three hours later he had a temperature of 103.2 F.,

was rational and had approximately the same amount of hearing as when first examined, but complained of nausea and severe frontal headache. There had been no discharge from the ear for twenty-four hours. The membrane visible beyond the exostoses was gray and presented no signs of inflammation. At 8 p. m. the patient was completely irrational and uncooperative. The neck was somewhat stiff and the Kernig sign suggestive, but it was hoped that this might be due to resistance to examination rather than to meningitis, as the patient's family insisted that he was suffering from one of his severe bilious attacks. The drum membrane at this time presented a blister in the region of the rivinian segment, but the canal was still dry. When the blister was broken by wiping the area with a cotton wound applicator, clear fluid began to flow from this point, continuing until death. No pulsation was noted. During the night a twitch of the right side of the face developed, which was evidently due to irritation of the facial nerve. Thursday the patient was admitted to Cooper Hospital with the diagnosis of meningitis. Death occurred Friday at noon. He was in a state of wild delirium from the time of admission until a few hours before death; this was only partially controlled by morphine. Spinal puncture was attempted, but was found to be impossible without a general anesthetic. Since the pulse rate varied from 130 to 160, this was not deemed advisable. A roentgenogram of the mastoids was not taken for the same reason. Spinal fluid was again collected from the external canal. This fluid was still clear, but contained a few leukocytes and cocci. Culture was later reported as yielding Micrococcus flavus. The blood count was: red cells, 3,640,000; white cells, 24,050; hemoglobin, 75 per cent; polymorphonuclears, 91 per cent, and lymphocytes, 9 per cent.

Autopsy.—A dense suppurative exudate was found over the vertex and frontal lobes, with some involvement of the vermis. Both temporosphenoidal lobes were grossly free from exudate, the right side showing no more involvement than the left. No tumors or abscesses were found in the brain, all disease apparently being confined to the meninges. A cross-section of the cord at the foramen magnum appeared normal. On the superior surface of the right temporal bone between the arcuate eminence and the petrosquamous suture there was a circular opening in the dura and bone about 2.5 mm. in diameter. The dura surrounding this opening was smooth and free from adhesions, and it seemed to dip down into the opening, resembling a natural foramen. A probe placed in this opening passed through a small fistulous tract into a sac attached to the posterior bony wall of the tympanum. The walls of the sac and tract consisted of soft, friable tissue of a brownish color. No pus or gross signs of inflammation were found in the mastoid. The nasal accessory sinuses were not explored. Pus taken from the exudate over the vertex yielded a pure culture of pneumococci.

The specimen of the involved area of the temporal bone was shown to Dr. Eagleton. He stated that he had never seen a condition resembling this, and suggested that the fistulous tract and sac be sectioned. The report from the laboratory of the Newark Eye and Ear Infirmary was as follows: A section from the fistula showed brain tissue in the center of which appeared to be a canal about 0.25 mm. in diameter. This canal had a thin lining, but was so much degenerated that the type of lining cells could not be identified. This fistula was possibly the duct of a congenital cyst. There was no evidence of inflammatory tissue around the cyst.

COMMENT

Autopsy definitely established the route by which cerebrospinal fluid entered the external auditory canal; however, there are certain phe-

nomena yet to be explained. Why should this sac have ruptured after fifty-four years in the absence of trauma, undue muscular exertion or demonstrable infection? Could the infection causing the meningitis have entered by this route without causing reaction in the meninges immediately surrounding the opening in the dura? If the infection of the meninges occurred by way of the external auditory canal, one would not, ordinarily at least, expect the pneumococcus to be the exciting cause.

After going over the data in this case Dr. Eagleton expressed the opinion that infection of the sphenoid sinus should be considered as the possible focus of infection resulting in meningitis, and that the rupture of the membrane permitting the escape of cerebrospinal fluid into the external auditory canal was possibly incidental. Unfortunately, the sphenoid was not opened at autopsy, so this theory can be neither confirmed nor excluded. In this connection I am quoting a paragraph from Eagleton's writings on the relation of the sphenoid to pneumococcic meningitis:[4]

> A series of autopsies has convinced me that when pneumococcic meningitis follows a cold in the head, the sphenoid should be suspected of containing the principal focus of infection which had ultimately resulted in the development of the meningitis, provided, of course, that no other infection, such as otitis or pneumonia, has been present *prior to the original headache.*

If the meningitis were of sphenoidal origin, an explanation of the cerebrospinal otorrhea might be offered. Let it be assumed that a pneumococcic embolus from the sphenoid entered a pial vessel causing a local abscess within the arachnoid. This irritation of the meninges resulted in an increase in volume of the cerebrospinal fluid, but before the intracranial pressure had become sufficient to cause definite headache the degenerated walls of the congenital cyst gave way, permitting the excess fluid to escape by way of the external auditory canal. This opening in the dura may have prevented headache until overwhelming infection occurred, if one can conceive of a localized meningitis giving rise to no other symptom than increased intracranial pressure.

On the other hand, if the degenerated sac ruptured spontaneously, it is not altogether illogical to assume that pneumococci were introduced into the ear canal by a handkerchief contaminated with nasal secretions and thence entered the subdural space, immediately causing a generalized meningitis. Since bacteria entered the subdural space directly rather than from an overlying infection, a reaction would not necessarily occur at the place of entrance.

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4. Eagleton, Wells P.: Suppurative Meningitis of Otitic and Nasal Origin, Arch. Otolaryng. **15**:885 (June) 1932.

SUMMARY

1. Spontaneous cerebrospinal otorrhea is an extremely uncommon condition.

2. Autopsy in the reported case established the existence of a preformed pathway from the subdural space to a sac or cyst in the middle ear.

3. The finding of brain tissue in the walls of the fistulous tract supports the conclusion that this canal was congenital in origin rather than the result of an infantile suppuration.

4. The immediate or exciting cause of rupture of this sac, permitting the escape of subdural fluid from the external auditory canal, has not been definitely established.

5. The terminal meningitis was caused by the pneumococcus, but evidence supporting any one pathway of infection is somewhat inconclusive.

414 Cooper Street.

TREATMENT OF MALIGNANT DISEASE OF THE TONSIL WITH HIGH VOLTAGE X-RAYS AND RADIUM

RICHMOND McKINNEY, M.D.
MEMPHIS, TENN.

Doubtless one of the most hopeless sites of malignant growth at which to use treatment by radical surgical measures is the faucial tonsils, but in recent years there has been some hope offered in the treatment of the unfortunate patients through the medium of roentgen rays and radium, a therapy which seems to be showing a reasonable percentage of so-called cures. Even should this treatment not prove absolutely curative in most cases, the fact that one can by means of it give to the sufferers a prolonged and more comfortable life is in itself a constructive achievement in therapeutic progress.

Naturally one looks to the larger hospitals caring for patients with cancer for comparative statistics and for experimental work in treatment, as to these centers come patients from every direction, and such concentration gives an opportunity for study and experimental treatment that is not afforded the clinicians in smaller centers. Nevertheless, physicians who do not see many patients with cancer are just as vitally interested in the results of treatment and just as desirous of applying the best treatment, especially since most of their patients are financially unable to go to the hospitals for cancer in the larger cities.

In reviewing the case records of the Baptist Memorial Hospital, the largest hospital in my own city, where there are 425 beds, with an average admission rate of 11,500 per year, I found that during the past three years there have been only 6 patients with malignant disease of the tonsils admitted to the hospital, 2 of these having been under my care. On the other hand, Coutard [1] reported the results of treatment of only 46 patients with cancer in the tonsillar region with roentgen therapy at the Radium Institute of Paris during seven years, from 1920 to 1926, inclusive. Considering the large number of patients with cancer who apply at this institute for treatment, the number of patients with malignant growths of the tonsil who have been treated at the Baptist Memorial Hospital during a three year period is not comparatively small. There have been a number of patients with oral cancer admitted

Read at the Fourth Pan-American Medical Congress, Dallas, Texas, March 21, 1933.

1. Coutard, H.: Radiophys. et radiothérapie **2**:541, 1932.

to the hospital, but I shall consider only those in whom the condition was limited to the tonsillar region. Duffy [2] reported and reviewed 122 histologically proved cases of cancer of the tonsil treated at the Memorial Hospital from 1921 to 1928, inclusive. Berven [3] reported 42 cases of carcinoma of the tonsil treated between 1919 and 1927.

Coutard treated his patients with roentgen therapy alone. He claimed that in the series of 46 cancers of the tonsillar region already mentioned, 12, or 26 per cent, were cured. No local recurrence developed in any of the patients, and the proportion of metastases occurring more than two years after treatment was 1 in 12, or 8 per cent.

Coutard said that since 1926 the results of treatment of cancer of the tonsillar region have improved; that the primary cancer and glandular invasions have been cured in 46 per cent of the cases—which sounds extraordinary to me.

Duffy classified his cases into early and advanced, according to the extent to which the lesion had spread. Of the 122 cases, 33 were early and 88 advanced. Only 51, or 41.8 per cent, of the patients were without cervical metastases when admitted. His method of treatment is as follows: A combination of external and interstitial irradiation is used. High voltage roentgen therapy is applied to each side of the neck, the beam including both the primary lesion and the areas of lymphatic drainage. Immediately after this, the radium pack is directed over the primary lesion and the adjacent cervical region. Full erythema doses are used. This amount of radiation delivers from 150 to 180 per cent of a skin erythema dose to the tonsillar region. Radon is then implanted in the neoplasm.

The amount of radon needed is judged from the histologic grade of the tumor, its size and shape and the clinical response to external irradiation. In some cases in which there are operable metastases, dissection of the neck is performed when the cutaneous reaction is about healed. If the primary growth is of a highly radiosensitive type, radical surgical treatment of the nodes is not undertaken, dependence being placed on the surgical exposure of the node and the implantation of radon in full dosage in gold tubes. In the more advanced cases, the interstitial irradiation is buried through the skin without incision. The latter method is used in the treatment of advanced inoperable growths, whether the type cell of the neoplasm is radiosensitive or radioresistant.

In order to evaluate the efficacy of external irradiation, Duffy considered the patients in two groups. The first group included those treated between 1921 and 1924, inclusive. About 1925 the dosage for external irradiation was increased, and later 4 Gm. of radium element

2. Duffy, J. J.: Surg., Gynec. & Obst. **54**:539 (March) 1932.
3. Berven, E. G. E.: Strahlentherapie **42**:113, 1931.

pack was added to the hospital equipment. In the earlier group, 50 per cent of the patients remained free from regional metastases, and 66 per cent of those living two years or longer had no evidence of cervical involvement. For the later group, the corresponding percentages were 72 and 77. After the beginning of 1925, gold tubes replaced glass seeds. They were found much more efficacious in the destruction of the primary growth; the percentage of local recurrences decreased from 30 to 24 in the later period. Necrosis, with subsequent slough and hemorrhage, caused much trouble when the glass seeds were used. There has not yet been sufficient time to judge the five-year results in the group treated since 1925. The material before 1925 consisted of 49 cases; 10, or 20.4 per cent, of the patients survived the five-year period. One patient died without cancer just at the close of this period. If this case were added, the percentage would be 22.4.

Of the 13 patients who had no cervical involvement throughout, 5, or 38.4 per cent, are well. In 13 metastases developed after admission; none of these is well. Fifteen had operable nodes on admission, and 4, or 26.6 per cent, are well. One of the 8 who had inoperable nodes on admission is well.

Duffy concluded that carcinoma of the tonsil should be treated by irradiation therapy, or by irradiation and surgical treatment for certain metastases, but not by surgical treatment alone.

Berven, reporting on his series of 42 carcinomas of the tonsils, said that from 1919 to 1924 he treated the carcinomas with the x-rays from the outside, and with radium screens placed on the tumor on the inside. In his series of 23 patients thus treated there was no permanent cure, the period of freedom from symptoms being less than three years. Since 1924 he has been treating with radium as follows:

The radium is applied on three or four fields: (1) over the neck on the side of the tumor, (2) over the opposite side, (3) over the posterior part of the neck and (4) over the cheek. Six tubes, 11 by 2.5 mm., are applied for one hour each; filtration consists of 0.35 mm. of aluminum plus 0.3 mm. of platinum, the total filtration, with the applicator, being equivalent to 5 mm. of lead. The tubes are placed over a circular area about 5 cm. in diameter. The surrounding tissue is protected by 6 cm. of lead. The applicator is 6 cm. from the skin. About 30 per cent of the surface intensity reaches the tonsil from the area on the same side.

Of 14 patients treated from 1923 to 1927 with the new technic, 4 or 28.6 per cent, did not improve; 4 improved, 1 living nearly four years; 2 were free from symptoms for thirteen and twenty-seven months, respectively, and 4 were free from symptoms for three, four, four and one-half and five and three-fourths years, respectively.

In discussing the differential diagnosis between syphilis and malignant tumor, Berven stresses that antisyphilitic treatment can reduce the necrosis and the size of a malignant tumor, particularly if syphilis is also present. This clinical fact is borne out in the history of a case I shall presently report.

The statistics just quoted, taken mostly from abstracts in the 1932 "Year-Book of Radiology," give a comprehensive and an analytic consideration of the occurrence and treatment of malignant disease of the tonsillar region. They are of value to the surgeon who sees an occasional case, and who naturally seeks to use for his patient the most approved method of treatment, and the one that gives the greatest promise of prolonged life or of a cure in the accepted sense.

I was interested in a talk made by Dr. Henry Schmitz [4] of Chicago before a meeting of the Southern Interurban Obstetrical and Gynecological Association in Memphis, on Feb. 13, 1933, in which he argued for the use of high voltage roentgen treatment for patients with cancer rather than the application of radium, largely for reasons of economy and availability. He stated that there are approximately 90,000 cases of cancer annually in the United States, and that to treat all the patients with radium would be impossible. He said that roentgen treatment would accomplish just as much in these cases, and would cost only about one-ninth as much as radium. By the establishment of centers for high voltage roentgen therapy throughout the nation, the 90,000 patients could receive treatment at a total cost of about $11,000,000, whereas to treat the same number of patients with radium would cost $97,500,000, if the radium could be found.

Coutard is using high voltage roentgen treatment exclusively, and from a colleague who has recently returned from Paris, where he visited Coutard at the Radium Institute, I learned that he is using an intensive form of high voltage roentgen therapy for cancer of the tonsil as well as of other portions of the body, the technic and results of which he is not yet ready to describe. So far as I can learn, the method consists in treating the patients twice daily, the rays being filtered through a screen that would be the equivalent of 2 mm. of copper. The same areas of exposure are treated as with the old method, but with the filter that he uses he seems to get rid of the alpha and beta, or burning, rays entirely, which are filtered out, and gets only the gamma, or curative, rays. He is thus able to use frequent and intensive treatments. One patient with cancer of the tongue involving the tonsil was shown to my colleague; he had received 10,000 roentgens over a period of sixty-six days, twice daily, corresponding to 18 or 20 erythema doses. This patient's

4. Quoted in Memphis Commercial Appeal, Feb. 14, 1933.

skin showed no hardening, but a decided bronzing. From 5 to 8 patients who were taking this intensive treatment without burns were seen daily. Coutard stated that he does not hesitate to give the treatment indefinitely, so long as the patient does not show a systemic reaction. Coutard expressed himself as believing that in a few years high voltage roentgen treatment for all kinds of cancers will entirely supplant surgical treatment.

When palpable glands of the neck are found in malignant conditions of the tonsil, it is generally regarded as good practice to use block dissection. This should be complete, involving ligation of the external carotid and resection of the sternocleidomastoid muscle and the jugular vein. There is doubt, from the experience of some investigators, as to whether this really is of much worth in preventing glandular dissemination, the argument being that if the glands have become involved to such an extent, the chances are that the removal of these palpable glands may be useless, since glands lower down may be involved. However, it is the opinion of the majority of surgeons who have had extensive experience with cancer of the oral cavity that cervical block dissection, after the application of radon seeds and high voltage roentgen therapy, is attended by the most favorable results. Dr. Shields Abernathy of Memphis, a general surgeon with whom I have been associated in the application of radium in several cases and who has had considerable experience in the treatment of cancer of the oral cavity, has found that the cases in which he has used block dissection following the customary irradiation have given the most lasting results. I have seen some of his cases in which more than five years after such treatment there was no evidence of recurrence either at the original site or by metastasis. It is sometimes rather difficult, if not impossible, to persuade a patient who has been cured by irradiation so far as he is concerned to consent to an operation. If an operation is necessary, there should be a definite understanding with the patient before the application of radiation that he is to have the block dissection.

My observation and experience in the treatment of malignant disease of the tonsils have been with the combined use of radon implants and high voltage roentgen therapy. I shall now submit a report of 2 cases in which the technic and immediate results obtained by this method are clearly portrayed.

REPORT OF CASES

CASE 1.—A woman, aged 42, was first seen on Aug. 18, 1931, with the history of having a swelling in the right faucial tonsil for some weeks. There was pain shooting through the ear on this side, and there had been some loss of weight. There were no palpable glands in the neck, but she was anemic.

Examination showed a large new growth of the right faucial tonsil, extending from the tip of the lower lobe to the velum palati and over the right faucial pillar.

With punch forceps two fairly large portions of tissue were removed from the growth for histologic examination. The report from the laboratory of the Baptist Memorial Hospital was that the growth was a lymphosarcoma, with many mitotic figures in the tissue.

On August 27, after I had anesthetized the involved area with procaine hydrochloride, Dr. Abernathy placed ten radon gold implants in the surrounding tissues and throughout the growth. The next day the patient left the hospital. On September 24, she returned for high voltage roentgen treatment. On four successive days 342 roentgens was applied through a 0.5 mm. copper filter to the following areas: first day, the posterior part of the neck; second day, the right lateral part of the neck; third day, the left lateral part of the neck, and the fourth day, the right lateral part of the neck.

The patient was sent home; when she returned for further inspection on Jan. 22, 1932, it was found that the lesion had entirely disappeared, and that she was feeling fine. I have seen her again in recent months, and there is not the least evidence of recurrence at the original site or anywhere else in the body.

Lymphosarcomas are peculiarly susceptible to treatment by radiation, but they frequently are rapidly fatal. Case 1 is a splendid example of the benefit to be derived from irradiation of this type of growth. I shall watch with much interest the subsequent progress.

CASE 2.—A man, aged 68, was brought to me during the latter part of October, 1932, with the statement that for more than two months he had a growth on the right faucial tonsil, with enlargement of the glands of the neck on that side, for which he had been receiving treatments by local application, doubtless of nitrate of silver. He had very little pain, and had lost practically no weight.

A large, ragged growth involved the entire area of the right faucial tonsil, with marked extension into the soft palate and the pillars of that side. The cervical glands were greatly enlarged and very hard.

With punch forceps two large portions of tissue were removed from the growth, and blood was taken for a Wassermann test. The laboratory reported that the growth was a squamous cell epithelioma of the tonsil, and that a patient had a 4 plus Wassermann reaction.

Preliminary high voltage roentgen therapy was begun immediately, the dates and dosage being as follows: On October 10, 200 roentgens to the posterior part of the neck through a 1 mm. copper filter; on October 27, 342 roentgens to the right lateral side of the neck through a 0.5 mm. copper filter, and on October 28, 342 roentgens to the left lateral side of the neck through a 0.5 copper filter.

On October 28, with the patient under local anesthesia with procaine hydrochloride, Dr. Abernathy placed twelve radon gold implants in the surrounding tissue and the center of the growth. The patient returned home the same day, and I started him on intensive treatment with iodide of potassium.

Within a month the growth had entirely disappeared, the involved area was perfectly smooth, and there was just one small palpable gland, about the size of a buckshot. The patient refused block dissection.

It is too early to venture an opinion as to results in case 2, but the patient will be kept under observation and will receive further high voltage roentgen treatments from time to time.

COMMENT

I am of the opinion that malignant disease of the tonsil is treated most satisfactorily by blocking with high voltage roentgen treatment, implantation of radon gold seeds, dissection of the neck in a thorough manner and further high voltage roentgen treatment in the order given. A radical attack on the glands, either by interstitial irradiation or by surgical removal, should never be made until the primary lesion is treated, for that lesion is the distributing point not only for the cancer cells, but also for possible infectious conditions.

It would be very dangerous if patients were subjected to high voltage roentgen treatment alone at the hands of indiscriminate roentgenologists, for this treatment is capable of good results only when applied in carefully regulated doses and by a skilled roentgenologist. However, if Coutard's expectations are realized, surgical intervention in these cases may eventually be supplanted by intensive high voltage roentgen treatment.

My experience has been that of a rhinolaryngologist to whom these patients have come on account of conditions of the throat. I have felt happy to be so situated that I could have the aid of a competent general surgeon in this work and of the x-ray laboratory of the Baptist Memorial Hospital, which is well equipped for obtaining good results in the application of roentgen therapy.

899 Madison Avenue.

PROBLEMS CONCERNED WITH EMPYEMA OF THE PETROUS APEX

SAMUEL J. KOPETZKY, M.D.
NEW YORK

In January, 1931, Dr. Ralph Almour and I presented before the Section of Otology of the New York Academy of Medicine our conception of suppuration of the petrous pyramid. We then presented a study of the pathologic changes involved, the mechanics of invasion and the developmental stages of a new clinical entity. We proposed a new technic which we had successfully employed to meet the indications for surgical intervention which the pathologic changes of the lesion presented. We cited in detail our case histories and summarized the reasons for the recoveries and the deaths which occurred in the cases we studied.[1]

Our first presentation was also particularly concerned with clarifying a prevalent misconception which was general at that time. This misconception pertained to the underlying pathologic process which served to produce the clinical pictures rather loosely summarized as belonging to the so-called Gradenigo syndrome. We sought to establish the fact that the symptom complex of trifacial pain and paralysis of the abducens nerve, whether accompanied or unaccompanied by changes in the cytology of the cerebrospinal fluid and whether the symptoms came on coincidental with or succeeding the advent of an acute mastoiditis, must not be interpreted as clinical evidence of the presence of suppuration of the petrous pyramid.

We believe that we have succeeded in clarifying this question. Today it is fairly well established that palsy of the abducens nerve may be present in a case of suppuration of the petrosal pyramid, but the absence of this symptom does not preclude a lesion in the pyramid. In our own cases it has been absent more often than it has been present.

Furthermore, we specifically detailed the data on which a clinical and a roentgen diagnosis could be made; the cases which we presented and published illustrated the factors at issue definitely. Nor has a

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From the Otolaryngological Department of Beth Israel Hospital.

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1. Kopetzky, S. J., and Almour, R.: The Suppuration of the Petrous Pyramid: Pathology, Symptomatology and Surgical Treatment, Ann. Otol., Rhin. & Laryng. **39**:996 (Dec.) 1930; **40**:157 (March) 1931.

larger experience with such cases and the more intimate acquaintance with the management of them which a larger amount of clinical material gives us caused any revision of the diagnostic and therapeutic dicta then promulgated.

Today there still remains confusion about some fundamental points, and there also exists a considerable difference of opinion as to the efficacy of the surgical procedures advocated. It is hoped that a restatement of some aspects of the problem and a clarifying discussion will lead to the establishment of conformity of thought and action in handling and managing this type of case.

PNEUMATIZED TEMPORAL BONES

The cases reported by us and the ones which we together or individually have recognized clinically and in which we have operated successfully presented clinical pictures as outlined in our original communication. They all occurred in fully pneumatized temporal bones with well developed cell structure in the petrosal pyramids. Nor could the specific lesion we described have occurred in any other type of bone.

A noncellular petrous pyramid cannot coalesce and contain within its anatomic limits a frank collection of pus. Neither could our operative technic be applied to any type of bone other than a pneumatized petrosal pyramid. It is conceivable to drill a hole in a diploic or a sclerosed bone. How pus could gain access to distant parts of such bones, however, and form empyemas requiring evacuation presents a conception not to be found in classic descriptions of the pathologic changes in either diploic or sclerosed bone.

I submit that Wittmaack [2] has established the mechanics of pneumatization. I ask consideration of the fact that there must be a contiguity of tissue, as far as the epithelial tissue of the petrosal pyramid is concerned. From the tympanic cavity in contact with the atmospheric air (through the eustachian tube), the same steps must take place in the growth and the development of a pneumatized petrosal pyramid that take place in the growth and development of a pneumatized mastoid process. The same recession of the subepithelial strata of tissue, the same gradual absorption of marrow-filled cavities to the fuliy developed stage of cellular structure lined with similar epithelium and subepithelial tissues and nourished by blood vessels in the walls of the cells and the same subepithelial tissues are found as are present in the structures of cellular mastoid processes.

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2. Wittmaack, Karl: Ueber die normale und pathologische Pneumatisation des Schläfenbeines; einschliesslich ihrer Beziehungen zu den Mittelohrerkrankungen, Jena, Gustav Fischer, 1918.

I submit that such an anatomic set-up is subject to the same type of mechanical assault as that of similar type in the mastoid process, and that as a result of invasion by pathologic bacterial flora there results the same sequence of events to produce coalescence as has been so well observed and described by numerous observers of the lesion in the mastoid process (Wittmaack, Schiebe, Heine, Panse, Körner, Kopetzky and others). Strictly speaking, I am dealing with osteitis, and Eagleton discussed osteomyelitis.[3]

Fischer,[4] in his pathologic studies, stressed the difference in the two lesions. He questioned the presence of true haversian and Volkmann canals in the typical pneumatized, cellular type of bone. All anatomists agree that a certain percentage of petrosal pyramids are pneumatized, and there is ample evidence in my own observations that the lesions I have observed and on which I have operated occurred in such pneumatized specimens of bone.

When pneumatization is finished and the specimen is normal, the end-result is a fully pneumatized mastoid process. It is not unusual for the pneumatization to extend to the squamous, zygomatic and even the occipital bones. Pneumatic cells have been described around the mouth of the eustachian tube, on the floor of the middle ear and in the tegmen tympani. Cell tracts have been described leading to and including the tip of the petrosal pyramid by Siebenmann,[5] Girard,[6] Mangebeira-Albernaz,[7] Baldenweck,[8] Collet,[9] von Tröltsch,[10] Merkel,[11] Urbantsch-

3. Eagleton, W. P.: Unlocking of the Petrous Pyramid for Localized Bulbar (Pontile) Meningitis Secondary to Suppuration of the Petrous Apex, Tr. Am. Laryng., Rhin. & Otol. Soc., 1930, p. 338.

4. Fischer, J.: Studien zur pathologischen Anatomie des Schläfenbeines, Monatschr. f. Ohrenh. **59**:877, 1002 and 1092, 1925; **60**:137, 1926.

5. Siebenmann, F.: Mittelohr und Labyrinth, in von Bardleben, Karl: Handbuch der Anatomie des Menschen, Jena, Gustav Fischer, 1897, vol. 5, pt. 2.

6. Girard, L.: Perilabyrinthine Cells, Essai d'anatomie topographique du labyrinthe d'après des dessections practiques par la voie chirurgicale, Soc. de laryng., d'otol. et de rhinol. de Paris, Dec. 9, 1911; Ann. d. mal. de l'oreille, du larynx **38**:129, 1912; Arch. internat. de laryng., d'otol. et de rhinol. **33**:195, 1912.

7. Mangebeira-Albernaz, P.: Grande cellule pneumatique du rocher: Contributions à la pathogénie du syndrome de Gradenigo, Arch. internat. de laryng. **8**:1035, 1929.

8. Baldenweck, Louis: Etude anatomique et clinique sur les relations de l'oreille moyenne avec la pointe du rocher, Thèse de Paris, 1908, no. 154.

9. Collet, F. J.: Pneumatization de la pointe du rocher, Arch. internat. de laryng. **29**:449, 1923.

10. von Tröltsch, A. F.: Lehrbuch der Ohrenheilkunde, ed. 7, Leipzig, F. C. W. Vogel, 1881, p. 191.

11. Merkel, F.: Handbuch der topographischen Anatomie zum Gebrauch für Aerzte, Braunschweig, F. Vieweg & Sohn, 1891, vol. 1, p. 561.

itsch,[12] Eagleton [13] and others. Profant [14] studied the bones of three fetuses, two full-term infants and fifty adults, and stated that "a specimen with a well developed mastoid had a well developed petrous, and one with a sclerotic mastoid had a sclerotic petrous." Belinoff and Balan [15] studied forty temporal bones and found 22.5 per cent to be diploic, 42.5 per cent of mixed type and 35 per cent pneumatic. Identical types of structure in both mastoid and petrous processes were found in 37.5 per cent of cases. If one reads Zuckerkandl's studies of the mastoid process in two hundred and fifty specimens, it is seen that diploic structure was present in 20 per cent, the type was mixed in 43.2 per cent and the pneumatic type was found in 36.8 per cent. These figures are significant and should be remembered as in contravention of the contention of J. Gordon Wilson,[16] who examined the petrous bones of more than twenty children and found all of them to be diploic. I doubt that failure in technic during the preparation of specimens could have led the experienced anatomists mentioned into mistaking diploic cells for pneumatization.

The recent publication of Glick,[17] who made a detailed study of the degree of pneumatization, the type and amount of bone marrow present, the presence of suppuration in the antrum and the petrosal tip and the relationship of bony dehiscences directly under the gasserian ganglion, presents further and still more convincing data on the question at issue.

I shall not quarrel with Eagleton even though his case 3, which is reported as osteomyelitis, is definitely one of empyema due to osteitis. I think that we both see lesions in the petrosal pyramid but, peculiarly, in different types of bone—he in diploic and I in pneumatic bone. I am sure that we agree that osteomyelitis cannot occur in pneumatized bone, or else we should have to discard much of the teachings which Wittmaack has so laboriously established.

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12. Urbantschitsch, Victor: Lehrbuch der Ohrenheilkunde, ed. 2, Berlin, Urban & Schwarzenberg, 1890, p. 306.

13. Eagleton, W. P.: Localized Bulbar Cisterna (Pontile) Meningitis, Facial Pain and Sixth Nerve Paralysis and Their Relation to Caries of the Petrous Apex, Arch. Surg. **20**:386 (March) 1930.

14. Profant, H. J.: Gradenigo's Syndrome: With a Consideration of "Petrositis," Arch. Otolaryng. **13**:347 (March) 1931.

15. Belinoff and Balan: Ueber den Bau der Pyramidenspitze, Monatschr. f. Ohrenh. **64**:1185, 1930.

16. Wilson, J. Gordon: In discussion on Ballenger, Howard: Petrositis, Arch. Otolaryng. **17**:728 (May) 1933.

17. Glick, H. N.: Microscopic Observations of the Petrous Apex, Ann. Otol., Rhin. & Laryng. **42**:175 (March) 1933.

Furthermore, if additional data are needed, the autopsy material of Friesner and Druss [18] and of others demonstrates varying degrees of pneumatization of the petrosal pyramid.

The cases with which I am dealing occur only in pneumatized bones, present coalescence and are not cases of osteomyelitis; the surgical therapy I advocate for their relief is not applicable to cases of osteomyelitis of the petrosal pyramid. If the significance of these factors is fully comprehended, the reasons for the symptomatology and the rationalization underlying the surgical therapy will be easier to understand.

Since pneumatization goes out from the tympanic cavity and mastoid antrum, on the one hand to develop the adult type of pneumatized mastoid process and on the other to develop the pneumatized petrosal pyramid, the route of invasion becomes important. In our earlier communication we detailed these routes specifically. They are as follows:

1. From the antrum or epitympanic space, above or below the superior semicircular canal, following the posterosuperior surface of the petrosal pyramid into the tip.

2. From the peritubal cells into the pyramidal tip.

3. From the peritubal cells directly into the carotid canal, or through dehiscences in the anterior tympanic wall into the carotid canal, and then rupturing into the cavum meckii.

The avenues of invasion can be recognized macroscopically. Microscopic evidence supports the view that often the avenue of invasion is along the perilabyrinthine cells originating in the antrum and the epitympanic space.

The following observations were made. All cases occurred in pneumatized mastoid processes. At the original operation, cells were found to extend well forward into the zygoma. In the region of the antrum and the area posterior to the superior semicircular canal, cellular elements were present. In most of the cases with which we dealt there was suppuration in the mastoid process which, in all except one case, preceded the development of suppuration in the petrosal pyramid. In the exceptional case, the petrosal suppuration was simultaneous with the development of the mastoidal invasion, although the significance of the deep-seated orbital pain and the narrowing of the palpebral fissure was not realized in the beginning of the attack. It was subsequently recognized, and the patient was successfully submitted to operation (case 3 [1]). In the majority of instances, the suppuration in the mastoid process and the middle ear clears up, and an interval of time elapses before the onset of symptoms denoting that the suppurative process has spread into the perilabyrinthine tracts toward the pyramidal tip. When the

18. Friesner, I., and Druss, J. G.: Osteitis of the Petrous Pyramid of the Temporal Bone, Arch. Otolaryng. **12**:342 (Sept.) 1930.

middle ear becomes dry, there ensues, after a time, a reappearance of a profuse aural discharge, the origin of which cannot be traced to the mastoid wound. This profuse otorrhea is accounted for by the rupture of the bone-encompassed pus pocket into the middle ear, the avenue of egress usually being through the cells around the tympanic mouth of the eustachian tube and from these out through the tympanic cavity.

From these observations and the further study of additional cases, I am of the opinion that suppuration of the petrosal pyramid in pneumatized bones must be considered as a complicating lesion of purulent otitis media rather than as a sequela of purulent coalescent mastoiditis.

Furthermore, from the study of newer and more recent clinical material, the cases classify themselves into two groups:

1. The acute cases, wherein the purulent contents of the pneumatized petrosal pyramid are involved in an acute invasion, with dramatic symptoms which, if unrelieved, will lead to an intracranial invasion and the development of generalized leptomeningitis.

2. The chronic cases, wherein nature provides an egress for the encapsulated pus pockets. There is formed a fistulous tract from the petrosal pyramid which leads to the tympanic cavity, the empyema eventually escaping through the membrana tympani as persistent profuse otorrhea. Such cases do not necessarily lead to meningitis, but they are apt to eventuate in a chronic discharge from the middle ear. In a few instances, final healing results without additional surgical intervention.

CLINICAL DATA

The Acute Cases.—Following acute coalescent mastoiditis, which both roentgenologically and surgically has been demonstrated to be seated in a well pneumatized temporal bone, there usually occurs a short period of normal convalescence. The temperature is normal, the discharge from the middle ear ceases, and the mastoid wound heals. After a variable interval of time, the patient begins to complain of pain in the eye on the side of the lesion. At about the same time there occurs a sudden profuse discharge from the middle ear; but if the wound in the mastoid process is inspected, this discharge is found not to originate in the wound cavity. If the onset happens very early in the postoperative period, a discharge may be observed coming from the posterior antral opening into the mastoid wound. In many cases the mastoid wound will have healed at the time this complication of the infection of the middle ear sets in.

The patient has a slight rise in temperature, 99 F. in the morning and from 101 to 102 F. in the afternoon. The pain in the eyeball continues. It is most intense at night, with periods of remission during the morning. Eventually it becomes continuous. Transient perilaby-

rinthine signs appear. Sensations of dizziness and vertigo, sometimes severe enough to cause vomiting set in. These signs from the labyrinth assume the technical picture of labyrinthine irritation. There are often short periods of nystagmus which has no fixed direction. Specific labyrinthine tests are negative. The cochlear and vestibular functions remain unimpaired. The eyegrounds are normal. The blood gives no specific indicators that are significant.

The x-ray picture of the petrous pyramid, however, reveals distinct changes. If a picture of the base has been taken at the time of the original operation on the mastoid, the recognition of the changes is facilitated. When no diagnosis of the condition is made at this time, the symptoms continue until suddenly they all disappear. This period of absence of symptoms—the period designated as the quiescent phase—is the most dangerous one because of the false security which the freedom from symptoms brings to both patient and physician. It may last a considerable time. During it, the only diagnostic aids are the roentgenogram and the profuse otorrhea. In a case which is unrelieved surgically, the dramatic end of this period is ushered in with the development of generalized meningitis. In these cases no fistula forms, and the spread of the lesion is toward the endocranium.

In all the cases which I have seen and studied, I have not yet seen spontaneous recovery in one in which operation was not performed; nor to my knowledge has Almour or any other member of my staff, who are familiar enough with this work to recognize the clinical entity.

The details of diagnosis, the factors underlying the production of the symptom reactions and the differentiation of these reactions from those of lesions which simulate the clinical picture of suppuration of the pneumatized petrosal pyramid are fully recorded and published elsewhere and need not be restated.

When a patient presents the symptoms outlined, the elements of differential diagnosis have all been checked and there is positive roentgen evidence to substantiate the diagnosis, operation, and operation alone, is the indicated therapeutic agent in the cure of the patient and the eradication of the lesion.

The Chronic Cases.—These cases do not present a prodrome of meningitis. Nature has taken a hand in providing an egress for the pus accumulated in the petrosal pyramid.

In the more acute cases, the clinical picture closely simulates that in the acute cases described. Pain in the eye is present. In most instances the mastoid wound has healed. Sometimes periods ensue during which there is temporary ballooning of the postauricular scar tissue. Occasionally, at a weaker point in the newly healed wound a small break occurs, and purulent exudate finds egress. The signs of labyrinthine

irritation are less sharp. The headaches are more generalized. The patient feels poorly and shows this by his actions; he is vaguely unable to locate his complaint. The otologic observer cannot account for the persistence of the otorrhea in an acute case in which the onset, clinical course, operative findings and immediate postoperative period contain no indication that anything untoward has happened, or that a chronic discharge from the ear is to be expected. Often the mastoid wound heals uneventfully except for the incidents noted. The roentgen picture of the base of the skull, however, gives definite data on which the diagnosis can be made.

With such a history and in the absence of the sequence of events noted in the acute cases, a diagnosis of the presence of a fistulous opening into the pneumatized petrosal pyramid can be made. The whole clinical picture is one of less intensity. The difference between these cases and the acute premeningeal group is really one of degree rather than of kind.

Almour holds that he can make a diagnosis of the location of the fistula by the place from which the purulent discharge makes its appearance during the postoperative period. If it comes from the middle ear exclusively, he suspects the peritubal area as being the seat of the fistulous opening. If the discharge also appears to come from the upper regions of the mastoid wound along the epitympanic space, especially if it has previously been determined by roentgenograms that large cellular development is to be anticipated in the epitympanic area and zygoma, Almour expects the opening of the fistulous tract to be located at the junction of the horizontal and the superior semicircular canal, in the cellular structures of the perilabyrinthine areas. In a number of cases already reported and in others to be reported, these localizations of fistulous openings into the petrosal pyramid were thus determined and subsequently demonstrated at the operating table.

It is logical that since suppuration of the pneumatized petrosal pyramid is a complication of purulent otitis media, coalescence of the cellular structure of the bony wall may proceed in the mastoid process and in the petrosal pyramid simultaneously, and that the symptoms from the diseased mastoid by reason of their dramatic import may entirely overshadow the transient signs from the pyramid, or the perilabyrinthine irritation, pain in the eye and discharge from the ear may be computed as having origin in the lesion in the mastoid process. At the time of the operation on the mastoid process, when a fistula has established itself in the pyramid and the back pressure, which Körner, Panse, Kopetzky and others have described as being the fundamental factor in the continuation of the coalescing process, has ceased to exert its force, the further coalescence of the petrosal pyramid ceases. There then results a healing of the mastoidal lesion, with a fistulous tract from

the partially coalesced pneumatized petrosal pyramid which discharges pus through a perforation in the membrana tympani. This is the type of condition (not the acute necrotic type of Wittmaack) which ends in a chronic discharge from the middle ear.

The lesions in these cases eventually heal, sometimes without having been submitted to operation at all so far as the one in the petrosal pyramid is concerned. When the coalescence of the cellular elements in the pyramid has stopped because the pressure element has relaxed as a result of the original simple mastoidectomy, the partly broken down tip evacuates its detritus through the fistula which is spontaneously established. The signs from the fifth nerve disappear, and for a long time the middle ear is not dry. I have heard of a few cases in which the middle ear eventually became dry and the process healed.

Roentgen examination, preferably made immediately after an injection of iodized poppy seed oil 40 per cent through the tympanic cavity, may clarify the picture and by outlining the fistulous tract may show the nature of the lesion with which the surgeon is confronted. Even without the injection of iodized oil the x-ray picture will clear the obscurity and demonstrate the lesion, and the surgeon will know why he is confronted with chronic otorrhea as the sequela of acute coalescent mastoiditis.

Finally, this class of cases can be differentiated from the chronic cases outlined in that the latter have hardly any signs that specifically direct attention to the lesion. At the acute onset, the signs from the petrous pyramid are overshadowed, and thereafter there are no signs of significance, except the persistent otorrhea and the roentgenogram.

In all cases of acute coalescent mastoiditis, adequate operation on the mastoid process should be followed by a dry ear and restoration of the membrana tympani to its normal appearance and function. When these results do not follow, attention should be given to the possibility of a fistulous opening with a chronic discharge of pus from its tract through the middle ear.

SURGICAL TECHNIC

In the literature one will find records of sporadic cases of the types described, unrecognized for the most part for what they were clinically, which eventually came to autopsy and were studied macroscopically and microscopically. The lesion in the petrosal pyramid was found and reported as interesting and unusual. The lesions were described in detail and were recognized as purulent tracts which a given infection followed on its way from the tympanic cavity to the meninges. In a few instances, the findings at operation led surgeons beyond the usually exposed operative field, and on rare occasions these purulent tracts were traced and searched surgically with varying degrees of success. As these

observers did not understand the relationship of what was found to the symptoms which the patient presented or to the sequelae, none of them was able to develop the conception of a clinical entity or to generalize the indications for operative procedures on the petrosal pyramid from their findings. The exception to this statement is to be found in Lillie's [19] report on two cases. He was the first to report recognized cases and to operate on the patients following our original publication. Lillie reaches the tympanic orifice of the eustachian tube without going through the steps of the radical mastoid procedure, but his technic is applicable only to cases with a lesion in the epitympanic space. He is often misquoted as using his method for all types of cases.

General surgical principles, however, were laid down and definite procedures for attacking the lesion in the petrosal pyramid were proposed by Eagleton, Voss, Frenckner, Ramadier and Almour and myself. To sketch these procedures briefly, to analyze their accomplishments and to compare their purposes and results, while weighing their advantages and disadvantages, is now my purpose.

The technic that Voss [20] advocated for attacking the lesion is nothing more than a modified radical operation on the mastoid. He thoroughly exenterates the mastoid process and then makes a wide exposure of the epitympanic space. This, he said, suffices to permit adequate drainage of the petrosa.

I do not believe that this procedure is adequate for the following reasons, which are based on the observations of Almour and myself:

1. When no fistulous tract into the apex is demonstrable in the epitympanic space posterior to the superior semicircular canal, drainage from the apex will not be obtained and the danger to life will not be averted by this technic because the location of the lesion will not have been reached. The epitympanic space can extend to the juncture of the superior and horizontal semicircular canal; the lesion is in, or near, the petrosal apex.

2. When a fistulous opening is located anterior to the superior semicircular canal, a wider exposure of the attic is needed in order to expose such an opening properly. This would necessarily entail disturbance of the ossicular chain.

3. When a fistulous opening is located at the mouth of the eustachian tube, the technic employed by Voss will not expose it.

4. In addition to the foregoing facts, simple exposure of the fistulous orifice will not suffice for the cure of the lesion. It has been our experi-

19. Lillie, H. I.: Suppuration of the Petrous Pyramid: Report of Two Cases, Arch. Otolaryng. **15**:692 (May) 1932.

20. Voss, O.: Pyramidenspitzeneiterungen (Petrositis) an der Hand von 12 selbstbeobachteten Fällen, Acta oto-laryng. **15**:469, 1931.

ence in cases wherein a fistula into the apex was found that the tract into the apex was so narrow that it was insufficient for drainage of the encapsulated pus. This was demonstrated by the fact that widening of this tract by probing and drilling was invariably followed by a gush of pus under pressure. In addition, curettage of the apex through the opening should always be performed, a procedure that is impossible when the Voss operation is used.

5. Finally, when no fistulous tract presents itself, Voss' technic will not afford drainage to the pus within the apex. He does not enter unopened tracts; yet this pus sac must be opened and drained to effect a cure.

The technic of Frenckner [21] consists in entering the petrous apex through the arch of the superior semicircular canal. When the wide exposure of the attic is completed, he employs a fine curet especially designed for the purpose, and removes the cancellous tissue contained in the quadrant between the horizontal and superior canals, until the arch of the superior canal is outlined. He then follows this tract of cells underneath the arch of the superior canal, working forward and inward until the tip is entered and the pus evacuated.

Almour and I do not believe that Frenckner's technic is adequate for all cases for the following reasons, based on our own observations:

1. When a closed empyema of the petrous apex is present and there is no fistulous opening demonstrable at any point, the presence of a tract of cells under the superior canal is by no means certain. Rather dense perilabyrinthine bone is more apt to be encountered. In view of the dense bone encountered, and the fact that the tract is followed under the arch and then between the cochlea and the superior petrosal surface, the blind production of such a path into the apex becomes difficult.

2. On the other hand, when a fistulous opening presents either in front or behind the superior semicircular canal, the tract into the apex is already established by nature, and no artificial opening into the apex is needed. All that is required in order to reach the apex is the use of the probe to determine its direction and to widen the tract and of the burr to increase its periphery. Curettage of the apex can then be performed through this natural opening.

3. When a fistulous opening into the apex is located at the mouth of the eustachian tube, Frenckner not only does not expose this and so make use of it to drain the apex, but deliberately creates an artificial tract which cannot guarantee an entrance into the apex unless cellular tissue is encountered all the way.

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21. Frenckner, P.: Some Remarks on the Treatment of Apicitis (Petrositis) With or Without Gradenigo's Syndrome, Acta oto-laryng. **17**:97, 1932.

4. There is no drainage established at the most dependent portion of the pyramid, as Frenckner himself stated.

Ramadier, Guillon and Becker [22] stated that all the methods of approach so far described are inadequate in affording proper drainage for the pus in the apex. They have worked out a technic on the cadaver which they consider adequate. Through the usual incision in the mastoid carried slightly under the auricle, they perform a radical mastoidectomy. The membranous canal is then completely dissected away from the bony canal, and all soft parts are freed so as to expose the glenoid fossa. The capsule of the mandibular joint is then separated from the anterior wall of the canal, and the entire anterior bony wall and part of the floor of the canal are removed with a rongeur. The tegmen tympani and tegmen antri are next removed. The posterosuperior part of the glenoid tubercle is then resected. All these procedures bring into view the tympanic tubal orifice and the anterior wall of the middle ear. The carotid artery is then exposed by removing the bone of the anterior wall below the tubal orifice. This exposure of the ascending portion of the carotid artery is extended upward, and the entire horizontal portion and bend of the artery located in the petrous bone are exposed. A ligature is then passed around the artery so as to enable the operator to pull it out of its canal. The petrous apex is then entered through the inner wall of the carotid canal, and the apex is evacuated of pus, curetted and drained.

While this procedure, as yet unattempted on living persons, enables one to attack the petrous apex directly, it has the following serious disadvantages:

1. It opens a direct pathway into the endocranium by the wide exposure of the carotid canal, so that pus draining from the apex bathes the carotid artery and finds its way into the periyascular dural spaces, the very factor that we are trying to avoid.

2. The elasticity of the carotid artery and its constant pulsation block the drainage from the apex by sealing off the opening into it, because after the operation the ligatures are removed, and the artery is allowed to fall back into place.

3. One cannot tell what interference may result with the function of the mandibular joint, which becomes involved when the proposed technic is used.

4. Such a radical method of approach may not be needed in an individual case. Our experience has shown that when a fistula is found, nothing more is needed for the cure of the lesion than simple evacuation, curettage and widening of the tract and the institution of drainage until the lesion heals.

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22. Ramadier, J.; Guillon, H., and Becker: Ann. d'anat. path. **9**:597, 1932.

Eagleton's [3] technic of unlocking the petrous pyramid consists in the performance of a radical mastoidectomy, the removal of the posterior buttress (the tegmen celluli, the sinus plate, the bone in the sinodural angle and the bone over Trautmann's triangle, which skeletonizes the posterior aspect of the petrous bone), the removal of the anterior buttress (the root of the zygoma, part of the zygoma, part of the squamosa and part of the anterior wall of the canal, which partly skeletonizes the anterior portion of the petrous bone and facilitates the elevation of the dura from the superior petrosal surface), the removal of the entire tegmen, and the elevation of the dura of the middle cranial fossa until the petrous apex is brought into view. A sharp curved hook is then used to remove the bone overlying the apex, and the tip is entered.

This method also reaches the tip, but it has the following disadvantages:

1. The procedure is advocated for all types of cases, whereas our experience has shown that such a radical operation is unnecessary in all instances.

2. The same exposure of the petrous apex can be secured through the classic approach by way of the gasserian ganglion, which requires less of an endocranial exposure and the results of which are far less disfiguring.

3. If a rupture through the apex has occurred and an epidural abscess has formed, the pus can be successfully drained, and the patient's life can be saved, by the less radical procedure of merely elevating the dura through a radical mastoidectomy wound and draining the epidural abscess.

4. If an encapsulated abscess of the tip of the petrosal pyramid is present, drainage through the subdural space is the least favorable of all methods proposed. Not only is it the most tortuous and the most likely to be interfered with owing to the obstruction of the overlying dura, but, additionally, the method locates the drainage point at the highest instead of at the most dependent portion of the lesion. The dura closes the opening made surgically and defeats the objective of the procedure.

5. Eagleton has stressed osteomyelitis of the pyramid. In osteomyelitis one does not deal with frank pus in a coalesced cellular bone. Drainage per se is not the goal in curing osteomyelitis; the goal is the removal of purulent bone marrow and haversian canal systems. How could small sequestrums be removed by the route which Eagleton uses?

We advocate our technic *only for the drainage of pus from the apex in cases of encapsulated empyema occurring in pneumatized pyramids*

without a demonstrable fistula. It is a technic adequate for the relief of this condition because:

1. It reaches the petrous apex.

2. It does so without exposing the endocranium or any structure which leads to the endocranium and which might furnish an additional pathway for the spread of the infection.

3. With a thorough knowledge of the anatomy, the technic is simple and requires little added time beyond the completion of a radical mastoidectomy.

4. From a study of the cases in which we have performed this operation, we conclude that this procedure is all that is needed for the ultimate cure of the lesion with cessation of the discharge.

5. Through the opening into the petrosa thus made, it is possible with a small flexible curet to perform a curettage of the petrous apex.

Our technic is the logical one for operation on an enclosed empyema of the petrous apex because:

1. The pathologic studies of Lange have shown that the point of spontaneous egress for pus within the petrous apex is via the peritubal cells.

2. Fistulous openings have been found by us in the middle ear, at the tubal orifice, at exactly the point we select for entrance into the petrous apex.

3. The direction of the tracts leading from the fistulous openings into the petrous apex is in a plane which forms an angle of 22 degrees with the axis of the external auditory canal.

4. Therefore, in enclosed empyemas of the tip of the petrosal pyramid we use the route indicated by nature to enter the tip and to evacuate the accumulation of pus.

We do not advocate our technic in the following types of cases:

1. Those in which a fistulous opening is found in the epitympanic space, either anterior or posterior to the superior semicircular canal. In these cases widening of the fistulous tract, thorough curettage and drainage usually suffice. In such a case, radical mastoidectomy is not necessary. If they do not suffice, a counteropening should be made according to our technic (case 2[23]).

2. Cases in which a fistulous opening is found at the mouth of the eustachian tube. In these cases nature has performed our technic for us, and widening, curettage and drainage of the tract suffice.

3. Those in which a rupture has occurred and an epidural abscess results. Although we have been successful in curing a patient with

23. Kopetzky, S. J., and Almour, R.: Empyema of the Petrous Apex: Further Observations and Case Reports, Ann. Otol., Rhin. & Laryng., to be published.

such a case by the employment of our technic alone, we believe that the epidural abscess should be drained by the subdural route in addition to the opening into the tip.

Our technic is the one of choice in cases of closed empyema because:

1. It is not disfiguring.

2. It enables one to tap the petrous apex in the shortest possible time.

3. Each of our patients in whom a suppurative meningitis was not present prior to our operation was cured by this technic.

4. No injury to the facial, the cochlear or the carotid artery has occurred in any of our cases.

CONCLUSIONS

1. There are two types of pathologic lesions in the petrosal pyramid, namely, osteomyelitis and coalescent osteitis.

2. In all publications, I have dealt exclusively with coalescent osteitis occurring in pneumatic bone.

3. The symptoms presented by such a lesion can be recognized clinically as an entity.

4. The technic which Almour and I advocate for this type of lesion has up to now proved adequate in our cases.

5. Except when a spontaneous fistula becomes established, this condition, unless relieved surgically, terminates in meningitis.

6. In doubtful cases it is better to search for the fistula, curet and help drainage when it is found than to miss an encapsulated focus of pus so near the tip, with its tendency to break through the perivascular tissue about the carotid artery or from tracts at the tip, and permit it to extend endocranially.

51 West Seventy-Third Street.

BENIGN TUMORS OF THE TONSIL

WITH SPECIAL REFERENCE TO FIBROMA

H. J. HARA, M.D.
LOS ANGELES

Benign tumors of the tonsils are rare. The growths in this region are papillomas, angiomas, lymphomas, adenomas, fibromas, lipomas, chondromas, teratomas and various forms of mixed tumors. The faucial tonsils are developed in the second branchial cleft. This is approximately the meeting place of the oral epiblast and the intestinal hypoblast. From an embryologic point of view, the union of the two different tissues forms a most favorable site for a neoplastic growth. The apparent discrepancy in the clinical observation and the embryologic postulate was explained by Fox (quoted by Bosworth [1]); the morbid processes in the tonsils occur chiefly in the early period of life, while in adult life there are general retrogressive changes of the lymphoid tissue and the tonsils become masses of inert structure.

According to Vidau,[2] the first report of a case of benign neoplasm of the tonsil was published by Robert in 1827, and the first complete monograph on this subject appeared in 1897 and was published by Ardenne.[3] To the beginning of the present century thirteen cases of true fibroma of the tonsil had been reported in the literature. These include a report of nine cases collected by Bosworth,[1] which was published in 1892. Of the remaining four cases, one was recorded by Eve,[4] two by Gevaert [5] and one by Paunz.[6] Subsequently thirteen additional cases were reported. These included one each by Prota [7] in 1901,

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From the Department of Otolaryngology, White Memorial Hospital.

Read before the Los Angeles Society of Ophthalmology and Otolaryngology, March 27, 1933.

1. Bosworth, F. H.: A Treatise on Diseases of the Nose and Throat, ed. 2, New York, William Wood & Company, 1892.

2. Vidau, G.: Hemorrhagic Fibroma of the Right Tonsil, Arch. ital. di otol. **38**:583 (Sept.) 1927.

3. Ardenne, J. F.: Tumeurs bénignes de l'amygdale, Paris, J. B. Baillière & fils, 1897.

4. Eve, P. F.: Removal of a Fibrous Tumor from the Tonsil, Nashville J. Med. & Surg. **7**:12, 1854.

5. Gevaert: Deux cas de fibrome de l'amygdale, Belgigue méd. **3**:161, 1896.

6. Paunz, M.: A Case of Fibroma of Tonsil, Orvosi hetil. **43**:343, 1899; abstr., Monatschr. f. Ohrenh. **33**:484, 1899.

7. Prota, G.: Fibromi delle tonsille, Arch. ital. di laring. **21**:97, 1901.

Lipscher [8] in 1902, Hédon [9] in 1905, Pynchon [10] in 1906 and Brunetti [11] in 1909, two by Béco [12] in 1914, one by Bruzzone [13] in 1921, one each by Kofler [14] and Trautmann [15] and two by Santi [16] in 1922 and one by Vidau [2] in 1927. In 1932, New and Childrey [17] reported sixty-three cases of benign tumors of the pharynx and tonsils which were observed in the Mayo Clinic from 1917 to 1930, inclusive. Of these, thirty-five were papillomas. Of the remaining twenty-eight benign tumors, thirteen were in the pharynx and eight in the palate, and only seven were of tonsillar origin. These included one lipoma, one chondroma, two lymphoid tumors and three cysts. There was no fibroma in their group, and a careful review of the recent literature fails to reveal any.

The tonsillar fibroma may be sessile or pedunculated. One becomes conscious of the existence of the sessile type only when it attains such a size as to interfere with the normal movement of the faucial muscles in the act of deglutition and later in speaking. The pedunculated form is far more common than the sessile type, and when well developed, the growth is so freely movable that it may easily be thrown forward on to the tongue or partly swallowed at will. During the unconscious hours of sleep it may fall into the laryngeal orifice and may interfere with respiration, though there is no recorded case in which the patient suffocated. There may be cough, salivation, nasal tone, breathing through the mouth and snoring at night. In many instances, however, the development is so insidious that the growth gives rise to no symptoms and its presence is accidentally discovered during an examination for other purposes or while the patient is looking down his own throat.

The size of the growth varies considerably. It is sometimes the size of a pea, while in other instances it may attain the size of a turkey egg, or it may completely fill the oral cavity. The tumor may be round, oval or kidney bean-shaped. It is usually single and limited to one side. In the series reviewed, seven tumors originated on the right tonsil and

8. Lipscher, S.: Operierter Fall eines Tonsillarfibroms, Pest. med.-chir. Presse, Budapest **38**:944, 1902.

9. Hédon, E.: Fibrome de l'amygdale, Montpellier méd. **20**:421, 1905.

10. Pynchon, E.: Fibroma of the Tonsil, Illinois M. J. **9**:208, 1906.

11. Brunetti, F., Jr.: Fibroma della tonsilla sinistra, Arch. ital. di otol. **20**:319, 1909.

12. Béco, L.: Fibrome de l'amygdale, Presse oto-laryng. **13**:70, 1914.

13. Bruzzone, C.: Quattro casi di tumori benigni delle tonsille palatine, Boll. d. mal. d. orecchio, d. gola, d. naso **39**:37, 1921.

14. Kofler: Fibroma durum tonsillae, Monatschr. f. Ohrenh. **56**:863, 1922.

15. Trautmann, G.: Ueber Fibrome an den Tonsillen und an der Schädelbasis. Ztschr. f. Hals-, Nasen- u. Ohrenh. **1**:241, 1922.

16. Santi, Giulio: Fibroma of the Tonsils, Osp. maggiore **10**:366, 1922.

17. New, G. B., and Childrey, J. H.: Tumors of the Tonsil and Pharynx (Three Hundred and Fifty-Seven Cases): I. Benign Tumors (Sixty-Three Cases), Arch. Otolaryng. **14**:596 (Nov.) 1931.

Summary of Cases Reported in the Literature

Author	Age of Patient	Sex	Site of Tumor	Symptoms	Description of Tumor
Eve [4]	8	M	L	Congenital tumor in healthy Negro boy; apparently no subjective disturbance	Tumor size of a turkey egg; tonsil pressed inward by tumor, which was also attached to submaxillary gland; tumor removed by dissection of neck
Curling: Lancet **1**: 137, 1858	51	M	..	Presence of tumor known for twelve months, rapidly growing of late	Large sessile growth attached to mucosa of soft palate nearly filling oral cavity; incision in cheek
Julia [18]	Adult	M	L	Tumor accidentally discovered; could be swallowed or thrown forward on the tongue	Freely movable tumor, size of a walnut, attached to left tonsil
Bourdon: Bull. Soc. de Paris **47**: 317, 1872	41	M	R	Vague pain in throat followed trauma twenty-five years previously; tumor of five years' duration; nasal voice developed and he snored at night	Hard, smooth-surfaced mass completely filling fossa, displacing uvula far to left; microscopically, central zone consisted of tonsillar and peripheral fibrous tissues; both contained small unilocular or multilocular hemorrhagic cysts
Delevan: Med. Rec. **21**: 296, 1882	23	M	L	Tumor accidentally discovered in a patient with advanced tuberculosis during a laryngeal examination; no subjective disturbance	Smooth-surfaced, light pinkish pedunculated tumor springing from left tonsil
Masse [19]	Adult	M	L	Cough from irritation of fauces	Small slender pedunculated tumor attached to lower third of tonsil; histologically, a vascular fibrous tumor
Lublinski: Monatschr. f. Ohrenh. **21**: 277, 1887	35	M	L	Tumor accidentally discovered in a syphilitic patient; no subjective symptoms	Small fibroma attached to lower segment of left tonsil
Lannois: Lyon méd. **59**: 326 1888	26	M	L	Existence of tumor known for six years; interfered with deglutition and gave rise to somewhat obscure neuralgic pains	Tumor attached to center of right tonsil by short pedicle
Koch: Ann. d. mal. de l'oreille, du larynx **14**: 541, 1888	22	F	L	Tumor of three years' duration; dysphagia and at times dyspnea caused by freely movable mass	Long pedunculated tumor attached to lower portion of left tonsil by short pedicle
Lefferts [20]	55	M	R	Painless, slowly growing tumor of many years' duration, recently causing dysphagia and slight dyspnea	Large dense tumor, covered with thin nonvascular membrane originating from right tonsil, extending across isthmus, covering whole tonsillar region
Gevaert [5]	61	M	L	Peculiar cough only when patient was lying down, following inspiration, succeeded by a series of convulsive expirations	Pedunculated tumor attached on posterior surface of anterior pillar extending down to base of tongue; fibroma containing many vessels
Gevaert [5]	37	F	L	Severe cough at night	Oval tumor with thin pedicle, originating from upper part of left tonsil, extending downward to base of tongue; microscopically, a telangiectatic fibroma
Paunz [6]	..	..	..	(Original article not consulted)	Tumor size of hazelnut projecting in relation to left jaw, removed with hypertrophied tonsil; microscopically, a simple fibroma

Porta [7]	50	F	L	History of repeated angina; no functional disturbance; no adenopathies	Pale pinkish hard pedunculated mass with a broad base originating from upper pole of tonsil; microscopically, a telangiectatic fibroma with the hyperplastic tonsil at base
Lipscher [8]	Adult	F	R	Not stated	Pedunculated hard tumor, size of pigeon's egg; microscopically, besides fibrous connective tissue, there were groups of lymph cells, resembling follicles, and small and large round cells infiltrating at several sites
Hédon [9]	50	M	L	Tumor of many years' duration, without functional disturbance except slight cough	Hard smooth-surfaced oval pinkish tumor, size of an olive; microscopically, fibrous periphery and fat in center
Pynchon [10]	31	M	..	Tumor began eight years previously following tonsillitis; no impairment of general health	Beginning in median line from uvula, mass went downward with simple curve; anterior pillar tremendously enlarged, tumor, size of pullet's egg, weighing half an ounce (14.17 Gm.)
Brunetti [11]	12	F	L	Tumor accidentally discovered five months previously while examining a carious tooth with a mirror	Round uniformly hard tumor with slightly granular surface, size of pigeon's egg, attached to upper pole by short wide pedicle; microscopically, central zone consisted of compact, dense connective tissue elements of which were heaped together without any sort of orderly arrangement
Béco [12]	17	M	L	No functional disturbance until sneezing brought up tip of tumor on to base of tongue	Cucumber-like mass, 4.5 by 5.9 cm., base of which originated in subtonsillar space, projecting downward to pyriform sinus; tumor removed in 1899
Béco [12]	32	M	..	Tumor of five or six years' duration; patient subject to repeated tonsillitis; no disturbance of eating, breathing or speaking	Mass projected on tongue by sudden expulsion of breath; it originated from anterior pillar; weighed 3 Gm.; 5.5 by 1.5 cm.
Bruzzone [13]	Child	..	..	Not stated	Small red mobile fibroma, size of a hazelnut; microscopically, peripheral zone hornified; deeper strata penetrated by papillae
Kofler [14]	Adult	M	R	Only slight disturbances and excused from military service	Had irregularly oval pedunculated grayish-white mass about size of plum; microscopically, fibroma of dura with translucent parenchyma and with original tonsillar tissue meshed within
Trautmann [15]	69	F	R	Dysphagia	Large pedunculated tumor, extending from uvula to base of tongue; microscopically, hard vascular fibroma coated with striated squamous epithelium
Santi [16]	16	F	R	Tumor accidentally discovered eighteen days before admission while looking down her own throat in a mirror; no functional disorder	Small red hard mass attached to left tonsil by thin pedicle; microscopically, two zones as in preceding one
Santi [16]	15	F	L	No functional disorder; slept with mouth open "for some time"	Small red hard mobile tumor, size of hazelnut; microscopically, periphery hornified, underlying parenchyma penetrated by irregular papillae
Vidau [2]	26	M	R	Coughing, salivation and nausea	Kidney-shaped tumor, size of large bean, attached to anterior and inferior part of pillar by long slender pedicle

fourteen on the left tonsil, and in five cases there was no statement as to the site of attachment.

The patients in whom these tumors appeared were of various ages. The patient in the case reported in this paper was the youngest, being 7½ years. Eve's [4] patient, a Negro boy 8 years of age, was said to have a congenital tumor. In the series just mentioned, there were four patients in the second, four in the third, four in the fourth, three in the fifth, two in the first, two in the sixth and two in the seventh decade of life. Julia,[18] Masse,[19] Lefferts [20] and Lipscher [5] stated that their cases occurred in adults, but they did not mention ages. (Paunz' case is not included in this tabulation.) Thus true fibromas are frequently found in patients who have not attained the fourth decade of life and in males twice as often as in females.

The color of the tumor is a pale pinkish rose. Its consistency is normally hard and woodlike. When the tumor is cut, the parenchyma presents a milky white, semitranslucent, cartilage-like structure. Histologically, its periphery is coated with thin stratified squamous epithelium, often undergoing horny degeneration, while the deeper and central zones are composed of more or less dense fasciculated poorly nucleated fibrous connective tissue which at times shows evidence of hyalinization. At other times, between the meshes of the fibrous tissue may be found small foci of cellular infiltration with numerous connective tissue cells and fibroblasts. In Hédon's case a few giant cells containing from 15 to 20 nuclei were found in the parenchyma. The fibroma is usually well vascularized, and recent hemorrhagic foci are frequently observed. In some cases the blood vessels and in others the lymphatic channels may be well marked, thus forming either telangiectasia haemorrhagica or telangiectasia lymphatica.

The diagnosis offers no difficulties. The characteristic color, the firm, resistant feel to the touch, the absence of pain and the adenopathy are typical of the benign nature of the tumor. A pure fibroma does not form metastasis. Tumors of the tonsil are readily differentiated from those of the nasopharynx, which tend at times to attain an enormous size, causing secondary necrosis of the surrounding structure. A fibroma of the nasopharynx may become sarcomatous, while one of the tonsil rarely if ever becomes malignant.

The prognosis as to life is excellent. The rational method of treatment is the surgical removal of the tumor. In Eve's case, because the tumor was large and attached to the submaxillary gland, the side of the

18. Julia: Gaz. d. hôp. **36**:182, 1863.

19. Masse: Polype fibro-muqueux de l'amygdale gauche; ablation; guérison, Bull. et mém. Soc. d. chirurgiens de Paris **11**:927, 1885.

20. Lefferts, G. M.: Immense-Fibroid Tumor of the Tonsil, Tr. Am. Laryng. A. **11**:62, 1890; M. News **55**:177, 1889.

neck was dissected and the growth removed through the opening. In another case a wider access to the tumor was made through an incision in the cheek from the angle of the mouth. Such a procedure, however, is rarely called for, as the approach can easily be made by the oral route. No instance is recorded in which there was troublesome hemorrhage either during or after the surgical manipulation.

REPORT OF A CASE

E. M., aged 7½ years, a normally developed and well nourished Japanese school girl, born in California, came to my office on Oct. 10, 1933, for an examination of the throat. The family history was irrelevant. During the course of an examination by a school nurse in May, her tonsils, particularly the right one, were found enlarged, and she was advised to consult a specialist. As she had

Fig. 1.—Tonsil (*A*) attached to the tumor (*B*), showing the cut surface.

no symptoms referable to her throat, no medical care was given through the months of vacation. On the opening of the fall term, the child was again examined, and her family was urged to seek immediate medical attention.

On inspection of the pharynx, the first impression was that she had a peritonsillar abscess. The uvula was slightly edematous and pushed upward and forward, the tip pointing to the left. The palatoglossus muscle was swollen and reddened. There was a pearly projection beneath the mucosa of the anterior pillar, not unlike the pointing of pus just before it ruptures in quinsy. On digital examination, however, what seemed to be a pointing of pus was a nodular projection from the mass, which was definitely indurated and well lobulated. The growth extended well upward into the tonsillar fossa. Only a small portion of the growth was seen between the two pillars, the true tonsillar tissue being displaced downward and almost hidden under the tumor. There was nothing remarkable about the nose, larynx or ears. The temperature was normal. The Wassermann reaction of the blood was negative, and analysis of the blood and urine revealed nothing of importance. Two weeks later the patient was admitted to the White Memorial Hospital.

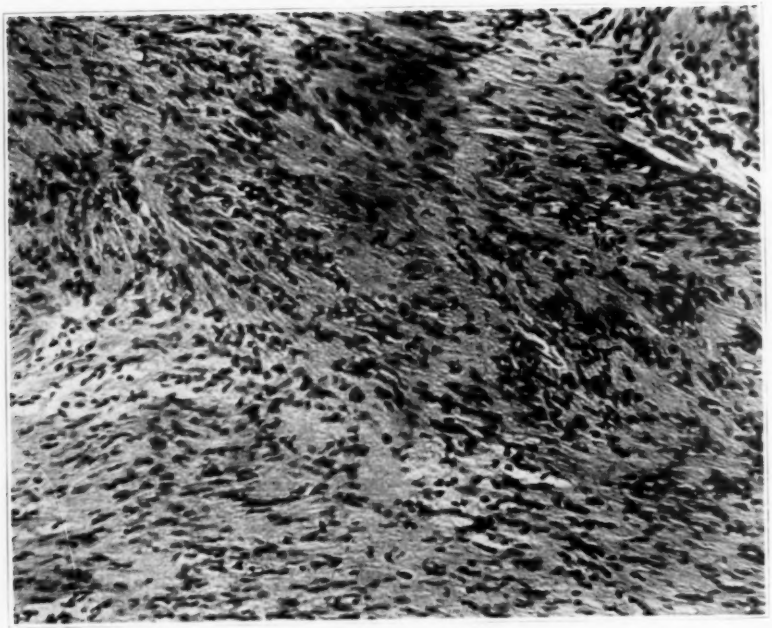

Fig. 2.—High magnification of section made through the tumor.

Fig. 3.—*A*, tonsil with its stratified squamous epithelium on the right lower corner; *B*, capsule; *C*, fibroma.

Under ether anesthesia, the tumor was dissected much after the usual technic of a tonsillar operation. The mass readily separated from its bed and was snared out together with the tonsil. There was little bleeding throughout the surgical manipulation. A close inspection revealed that the growth had originated from the fibrous layer of the tonsillar capsule and not from the pillars. The tumor was firm and pearly white. It, together with the tonsil, weighed 17 Gm. It was 50 mm. in length and 20 mm. in diameter at the widest portion (fig. 1). The left tonsil, which was removed at the same time, weighed only 4 Gm.

Dr. O. B. Pratt, of the department of pathology, reported as follows: The tumor was covered with a thin nonvascular mucous membrane of stratified squamous epithelium, beneath which was an indurated white connective tissue, the center of which showed some hyaline degeneration (fig. 2). The tumor appeared to originate from the fibrous layer of the capsule (fig. 3). It was a nonmalignant fibroma of the tonsil.

SUSPENSION CINEMATOGRAPHY OF THE LARYNX

F. E. LEJEUNE, M.D.
NEW ORLEANS

Suspension cinematography of the larynx offers a simple method for the accurate recording of pathologic conditions arising within, or closely related to, the laryngeal structures. The value of such records are obvious, particularly in the teaching of laryngology.

The consideration of suspension laryngoscopy and photography of the larynx recalls to mind the splendid and successful efforts of those stalwart pioneers who gave so freely of their time and energy in the development of these particular phases of laryngology. In 1846, Horace Green made important contributions, for which he was universally acclaimed "Father of Laryngology."[1] It has been generally agreed, however, that laryngology originated in 1855 and owed its creation to Manuel Garcia.[2] While Senor Garcia was not the first to conceive the thought of using two mirrors for examination of the interior of the larynx, he was the first to put it to practical use. Imagine the thrill and joy which surged through this profound student of laryngology, as he viewed for the first time the motions of the vocal cords. This epochal discovery was hailed with enthusiasm throughout the laryngologic world, and in 1905 laryngology united to pay a fitting tribute to Garcia and his discovery. The practical use of the laryngeal mirror was immediately recognized, and to the stimulus created by it modern laryngology owes its inception.

The use of laryngeal surgical procedures by the indirect method developed rapidly, and too much glory cannot be given to those laryngologists who so perfected their technic that the removal of growths from the larynx became for the initiated a common occurrence. However, the technic was difficult to master for both patient and doctor, and hours of education and cooperation were necessary for the ultimate success of one of the most exacting procedures known to surgery—the removal of growths from the vocal cords. The need for direct laryngoscopy was urgent. One hundred and twenty-six years ago, Bozzini obtained the first direct view of the human larynx, but due to the poor illumina-

From the Department of Otolaryngology, Tulane University.

Presented as a candidate's thesis to the American Laryngological, Rhinological and Otological Society, November, 1932.

1. Delavan, D.: Some Achievements in American Laryngology and Rhinology, Arch. Otolaryng. **8**:300 (Sept.) 1928.

2. Ewing, C.: The Pioneers of Laryngology, Laryngoscope **15**:198, 1905.

tion his procedure was of no practical value. Edison's contribution of the incandescent lamp marks a further step in the development of laryngology, and while indirect laryngoscopy served an excellent purpose in the examination and diagnosis of laryngeal pathologic processes, it fell far short when surgical measures were necessary.

The leaders in the field of laryngology realized that a more direct and accurate approach to the larynx was necessary if intralaryngeal surgical procedures were ever to be placed on a truly scientific basis. Laryngology is ever grateful to these master minds whose constant efforts made possible the development of direct laryngoscopy. Killian, Bruening, Jackson, Ingals, Lynch, Hasslinger and Atkinson are principally responsible for the perfection of the various direct methods in use today.

The most important contribution made to direct laryngoscopy, to my mind, was the accidental discovery by Killian of suspension laryngoscopy. At the culmination of a series of experiments, he presented his instrument at the International Laryngological Congress in 1912. Though correct in principle, it was not sufficiently perfect to be practical, and "while to Killian we owe the discovery of suspension laryngoscopy, it is to Lynch that we are indebted for the perfected instrument" and standardized technic for its use today.

At the beginning of my work in otolaryngology, I was taught the technic of suspension, and it is but natural that I should be partial to this method, particularly since I have found no other method giving as good a view or as easy an approach to pathologic conditions within the larynx. Suspension laryngoscopy as developed and taught by Lynch[3] surpassed all other methods for intralaryngeal surgical intervention. To those who are familiar with the technic of suspension laryngoscopy, a description of the excellent view obtained of the larynx, trachea and mouth of the esophagus is hardly necessary; suffice it to say that as a means of operative approach to the larynx and upper part of the esophagus as well as to the hypopharynx, suspension laryngoscopy offers many advantages. Deliberate inspection, palpation and consultation with the pathologist are advantageous in arriving at a diagnosis and in determining the type and extent of operation to be done. The development of two-handed surgical methods in this region is not only practical but necessary in many cases. Retraction of the cords for subglottic inspection is frequently necessary, and separation of the cords by means of a wooden spatula, only possible with suspension, has proved invaluable in the use of electrosurgical removal of growths involving the cords.

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3. Lynch, R. C.: Suspension Laryngoscopy as a Means of Diagnostic Approach to the Larynx, Ann. Otol., Rhin. & Laryng. **29**:416 (Jan.) 1920.

The brilliant results reported by Lynch [4] in dissection of intrinsic carcinomas and of other growths occurring in the larynx attest to the practical efficiency and accuracy of this method of approach. While my records are by no means so extensive, they are equally satisfactory.

Prompted by a thorough appreciation of the intricacies of laryngology and of its relative inaccessibility for teaching and demonstration, it has long been my desire to obtain from the normal and the pathologic larynx records of an exact and permanent nature that might be of some aid in the teaching of laryngology. Clinical photography is now being used extensively in all branches of medicine as a means of obtaining permanent records and for teaching purposes. Laryngology, owing to the inaccessibility of the parts concerned, has suffered, and laryngologists have had to be content with diagrammatic sketches for records and teaching. The desire for more accuracy in the recording of laryngeal pathologic processes has served to stimulate my attempts at laryngeal photography.

That the conception of this thought is not new is brought out by the fact that Cermak is credited with having made, in 1860, the first attempt at laryngeal photography. Lenox Brown, Solis Cohen and French were enthusiastic workers in this field, and French [5] obtained good results with an ingenious camera in which the sun's rays were utilized to illuminate the larynx. It is surprising to find how few investigators attempted to develop this phase of laryngology. In 1919, Garel presented his ingenious camera by which stereoscopic images of the larynx were obtained. Clerf,[6] in 1925, presented excellent pictures taken by this method. My attempts about the same time with the Garel camera were very unsatisfactory. In 1920, Hegener and Panconcelli-Calzia [7] of Hamburg reported successful cinematography of the larynx and, in 1930, Russell, using a fonopharyngoscope devised by himself, was able to obtain first-class photographs of the vocal cords in action. Heatly,[8] working with Morrison of the Eastman Kodak Company in 1931, presented the results of his experiments in motion pictures of the larynx, which were both interesting and good.

It was my good fortune to be intimately associated with Dr. R. C. Lynch in the conduction of extensive experiments in photography of the larynx extending over a period of years. While the results were

4. Lynch, R. C.: Cancer of the Larynx, Tr. Indiana Acad. Ophth. & Otolaryng., January, 1926.

5. French, T. R.: On a Perfected Method of Photographing the Larynx, New York M. J. **40**:653, 1884.

6. Clerf, L. H.: Photography of the Larynx, Ann. Otol., Rhin. & Laryng. **34**:101, 1925.

7. Hegener, J., and Panconcelli-Calzia, G.: Moving Pictures of the Vocal Cords, Vox **30**:114, 1920.

8. Heatly, Clyde A.: Motion Picture Studies of the Larynx, Ann. Otol., Rhin. & Laryng. **40**:434, 1931.

Fig. 1.—Camera set on tripod.

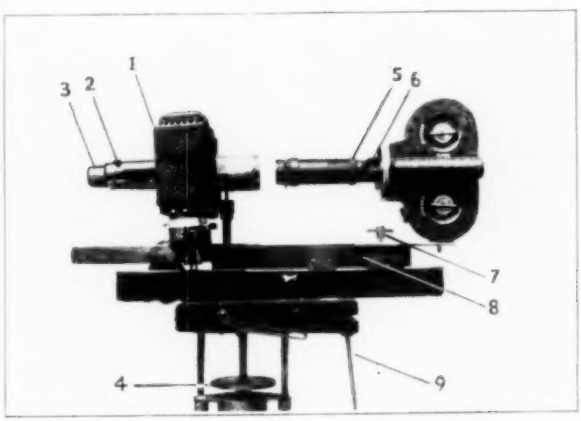

Fig. 2.—Camera: *1*, lamp house; *2*, condenser lens; *3*, turret tube; *4*, screw for elevating or lowering the tripod plate; *5*, focusing ring; *6*, reflex focuser; *7*, set screw; *8*, sliding arm; *9*, crank to angulate camera.

good, they were far from satisfactory and were unpractical. Stimulated by the memory of a beloved chief and realizing the advantages of suspension laryngoscopy, I resolved to attack from a new angle the problem of uniform and adequate illumination—qualities which are so essential in cinematography of the larynx. After much experimental work on

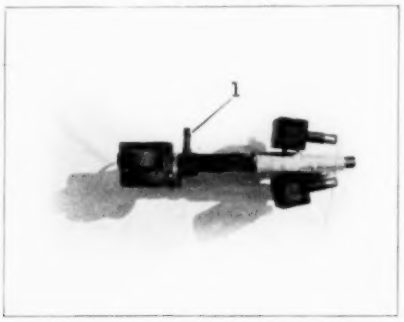

Fig. 3.—Plan view of camera and lights showing reflex focuser (*1*).

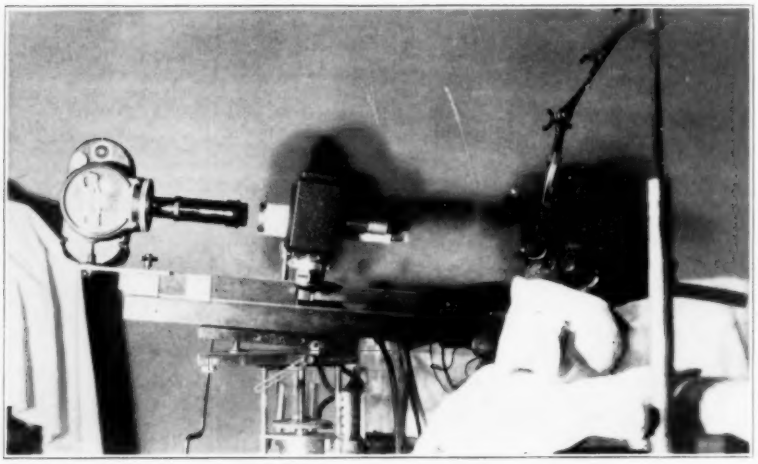

Fig. 4.—Camera in position.

an improvized manikin in which numerous lights and lens combinations were used, sufficient illumination was finally obtained by using two 200 candlepower projection type bulbs mounted in a lamp house and equipped with a condenser lens. These were placed on each side of a turret-like tube through which the lens of the camera was focused and an electric fan was directed on the lights to minimize transmitted heat. The camera, a 16 mm. Ciné mounted on a sliding arm on a tripod and

equipped with a reflex focuser to which is attached an F. 4.5 Göerz Dogmar lens, was used. The reflex focuser is a small optical instrument which screws into the lens thread of the camera and which has on the other end a threaded portion to receive again the photographic lens. At

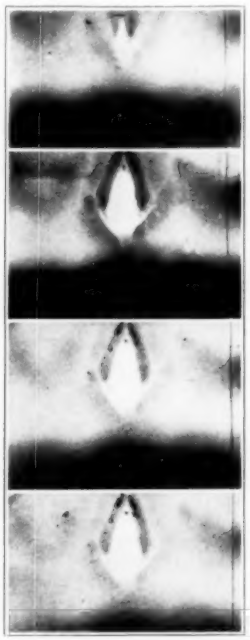

Fig. 5.—Normal vocal cords.

Fig. 6.—Paresis of the left superior laryngeal nerve showing relaxation of the vocal cord.

a right angle to the main body, a small tube projects which contains a movable right angle prism, a ground glass, a mask and a ten power magnifier. The prism can be shifted in and out of the path of the rays coming through the photographic lens and the object viewed and focused. After the focusing has been done, the image will be projected

into the film window in exactly the same relation as seen when the prism has been withdrawn into the small tube by means of a projecting knob. The focal distance ranges from 20 to 27 inches (50.8 to 68.5 cm.), depending on the use of extension rings which may be added between reflex focuser and photographic lens.

By means of suspension laryngoscopy, the larynx is exposed to direct view. The patient may have either local or general anesthesia. My preference for the latter is responsible for the fact that the majority of these pictures have been taken while the patient was asleep. As soon

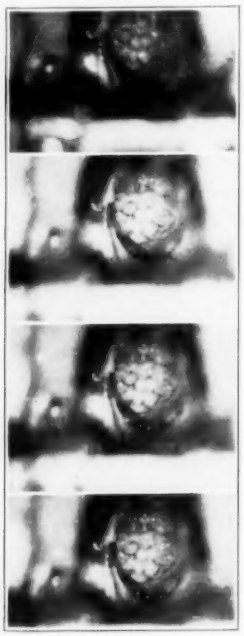

Fig. 7

Fig. 8

Fig. 7.—Multiple papilloma in a child, completely filling the larynx.

Fig. 8.—Hemangio-endothelioma at the junction of the false vocal cords and the arytenoid.

as the larynx is exposed, the camera on a tripod is placed in position and quickly and accurately focused by means of the reflex focuser. Pictures were obtained at normal speed, which is 16 frames per second, hence the necessity for intense illumination. In some views of the larynx in which there was little motion, pictures were obtained at one-half speed, or 8 frames per second, giving each picture more exposure. By using a smaller aperture, it was possible to obtain greater depth of focus. The successful cinematographic projection of the normal and of the pathologic larynx and the knowledge gained thereby have been sufficient

compensation for the time and effort expended in the development of this phase of laryngeal photography.

Relatively few laryngologists avail themselves of the opportunity and advantage of examining the larynx under suspension laryngoscopy. To those who are familiar with this technic, the cinematographic presentation offers little that is new. A number of good views of the normal larynx are presented for study. The rapidity of vibration of the vocal cords and the movements of the larynx and hypopharyngeal muscles are such that an ordinary examination by means of a laryngeal mirror, gives but a fleeting view, at best, of the larynx. Ability to study the movements of the larynx deliberately is obviously advantageous. Suspension laryngoscopy, on account of the pressure exerted, can never serve in the study of phonetics, but, contrary to statements made, there is practically no impediment to the motion of the arytenoids and vocal cords. In the first group of pictures presented these facts are brought out forcibly. The extreme abduction of the cords in deep inspiration and the complete adduction of the cords during the gagging reflex show the extent of the movements under suspension. The function of the arytenoids in the protection of the larynx is interesting and instructive to observe. A careful study shows what an important part the arytenoids play in the protective mechanism of the larynx. The epiglottis, under suspension, is held firmly and immobile. The gagging and coughing mechanism discloses the fact that each arytenoid approximates in the middle line, obliterating the intra-arytenoid notch and, with a rising motion, extends forward and upward, producing a sphincteric contraction over the larynx protecting from one half to three fourths of the posterior aperture. Were not the epiglottis held firmly in position, it would extend downward and contribute to the protection of the uncovered portion of the larynx.

Color photography is still in its infancy, and while it has been used in photography of the larynx,[9] it presents additional problems in that 30 per cent more illumination is required for each exposure. A new process for 16 mm. color photography is now available which offers distinct advantages over all others. I hope to be able in the near future to present a true color reproduction of pathologic changes as they occur in the larynx.

The advent of cinematography of the larynx on a practical basis, even though the science is far from perfect, opens a new field in the teaching of larynology and, with the progress and development which must follow, a better understanding of laryngologic conditions is inevitable.

9. Russell, G. O., and Tuttle, C.: Color Movies of Vocal Cord Action, Laryngoscope **40**:549, 1930.

Clinical Notes

A SELF-ADVANCING CATHETER FOR INTRODUCTION OF IODIZED POPPY SEED OIL 40 PER CENT INTO LUNG

LOUIS K. PITMAN, M.D., NEW YORK

The technic of introducing a rubber tube into the bronchus was originated by Green [1] in 1855, and further developed by Darter,[2] in 1893, Mandelbaum,[3] in 1922, Stitt,[4] in 1927, Garcia Vicente,[5] in 1928, Oughterson,[6] in 1931, and de Pablo,[7] in 1932.

Recently the introduction of iodized poppy seed oil 40 per cent into the bronchial tree as a diagnostic aid in pulmonary diseases, such as bronchiectasis and tumors, became of value. The methods in use for the introduction of the oil into the bronchial tree are bronchoscopic, intratracheal, deglutitive, intralaryngeal and supralaryngeal. The introduction of a rubber tube through the nose and thence down into the trachea is also advocated.

Oughterson [6] outlined the advantages of the intrabronchial injection of iodized poppy seed oil by means of a rubber tube, as follows:

"1. The introduction of the oil can be guided into any bronchus desired under fluoroscopic vision.

"2. A minimum amount of oil is used to outline the portion desired, without flooding unnecessarily other portions of the lung."

However, when the oil is allowed to gravitate down the trachea, the position of the patient is such that the oil cannot be guided into the upper or middle lobes where it may be desired.

By the use of the intrabronchial tube the injection can be controlled by direct vision under fluoroscopy. When it is desired to introduce the oil into the upper or middle lobes, the injection is made while the patient is lying prone on the side. The oil is watched as it emerges from the end of the tube and is directed into the bronchus desired by slightly changing the position of the patient.

I have had no experience with the Mandelbaum, Oughterson or any other instrument for the advancing of a soft rubber catheter into the bronchus, and I am therefore not in a position to discuss their merits. I am presenting my instrument, which operates in a different manner, and which I have found to be very practical.

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1. Green, H.: Injection of Bronchial Tubes, Am. M. Monthly **3**:5 (Jan.) 1855.

2. Darter, J. M.: Laryngeal Catheter, Texas Cour.-Rec. Med. **10**:41, 1893.

3. Mandelbaum, M. J.: Personal communication; Bronchoclysis, Arch. Phys. Therapy **13**:673 (Nov.) 1932.

4. Stitt, H. L.: Rubber Catheter for a Bronchial Tube, Tr. Am. Acad. Ophth. & Oto-Laryng., 1927, p. 369.

5. Garcia Vincente, S.: Injections into the Trachea, Progressos de la clin. **36**:457 (July) 1928.

6. Oughterson, A. W.: A New Forceps for Intrabronchial Injection of Iodized Oil, Arch. Otolaryng. **14**:617 (Nov.) 1931.

7. de Pablo, V.: Simple Technic for Intra-Pulmonary Therapy, Siglo méd. **89**:49 (Jan. 16) 1932.

The instrument resembles, and is held in the same manner as, a pistol. When the wheel is turned by the index and middle fingers in the direction of the arrow, the catheter advances. This enables the operator to advance and direct a catheter with one hand while the other hand controls the laryngeal mirror. There is an adjustable biting block on which the patient may clamp his teeth in order to keep the instrument in situ during the injection and visualization of the oil.

DIRECTIONS FOR USE

The procedure is simple. The mucous membrane of the pharynx and larynx is thoroughly anesthetized with equal parts of 10 per cent cocaine and epinephrine. The vocal cords are brought into view with the aid of a laryngeal mirror. A number 10 or 12 French soft rubber catheter is directed into the larynx and then into the trachea with the aid of the self-advancing catheter instrument. The patient bites his teeth on the tooth block to keep the instrument in situ. He is

The self-advancing catheter for the introduction of iodized poppy seed oil into the lung. When the wheel is turned in the direction of the arrow the catheter will advance. There is an adjustable biting block for the patient to clamp his teeth on to keep the instrument in situ.

then placed before the fluoroscope, and the tube is manipulated into the desired bronchus. A syringe containing the iodized oil is attached to the tube, and the amount of oil required to visualize the bronchus is injected.

The instrument is manufactured and distributed by George Tiemann & Co., New York.

115 West Eighty-Sixth Street.

NEW INSTRUMENTS FOR THE USE OF RIB CARTILAGE GRAFTS IN RHINOPLASTY

JACQUES W. MALINIAK, M.D., NEW YORK

The main essential of a cartilaginous support is that it fit properly into the defect to reestablish normal anatomic configuration. For reconstruction of the nasal dorsum, the cartilaginous graft must be straight in addition to possessing a definite thickness and width; it must have a length of approximately 5 cm. for

the dorsum and 4 cm. for the columella. The shape of the nasal graft is of the utmost importance to the end-result.

The most common sources of grafts are the cartilages of the seventh, eighth and ninth ribs. Because of their curvatures, it is often difficult to procure a uniformly straight graft.

The use of a flat or concave chisel for the removal of a cartilage graft from the rib is inadequate as it does not provide for a graft of equal thickness and therefore contributes to the curvature of the graft (fig. 1 *A*). The use of an

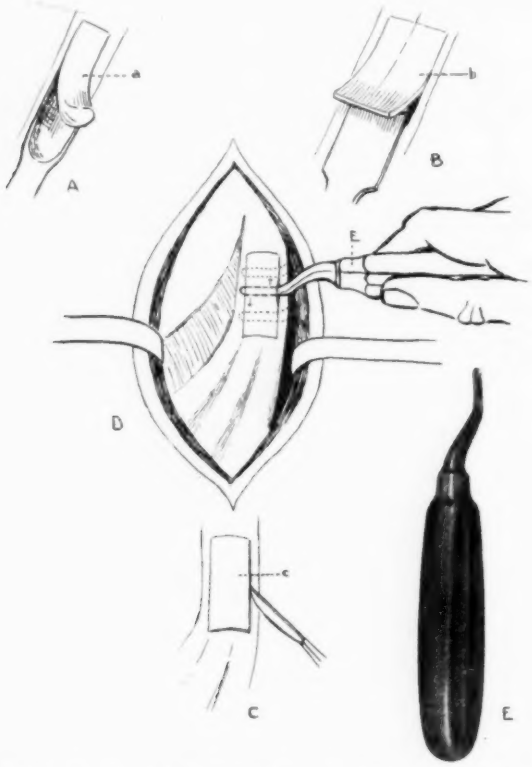

Fig. 1.—Method of obtaining a uniformly thick cartilaginous graft. The curling of a cartilage graft is often due to its uneven thickness, the tensile strength of the graft being greatest at the middle portion. The use of concave (*A*) or flat (*B*) chisels as advocated by some authors makes the procuring of a straight graft often difficult. *E* indicates the angular knife used by me in resection of the cartilage graft from the rib. As shown in *D*, the blade of the angular knife, after having transfixed the entire width of the graft, cuts the cartilage at a level parallel to its surface.

ordinary straight knife makes the procedure unnecessarily laborious because of the shape and position of the cartilages.

To obtain an evenly thick cartilaginous fragment, the blade must cut at a level parallel to the surface of the rib. The knife here described fulfils this purpose, as it is made to cut horizontally on both sides (Holstead model). To avoid puncture

of an intercostal artery or pleura, the end of the knife is rounded and slightly raised. The obliquity of the intermediate part between the handle and the blade permits its displacement in the horizontal plane (fig. 1 *E*). The ease with which the cartilage is cut at any depth makes it possible to obtain a graft of equal thickness throughout and leave a deep layer of cartilage in situ to maintain the continuity of the rib, thereby avoiding postoperative pain. This knife simplifies to a great extent the procedure of resection of cartilage from the rib.[1]

Besides having a graft that is straight, it is important to have one that fits simply into the subcutaneous tunnel in order to obtain the desired anatomic shape.

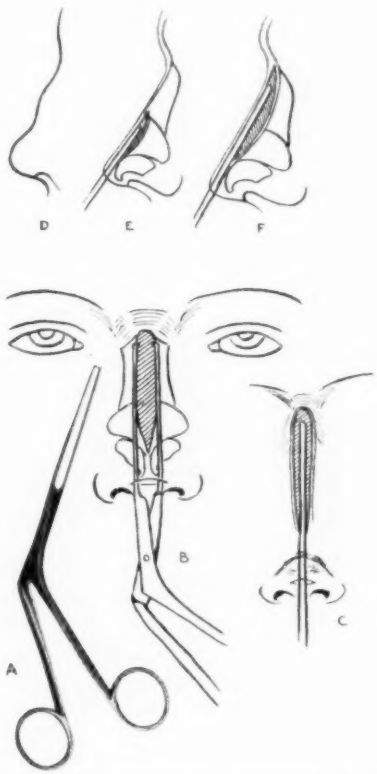

Fig. 2.—My cartilage introductor with extremely flexible branches which mold themselves exactly on the graft while the teeth penetrate into the substance, thus assuring a satisfactory grip. *E* shows a portion of the graft under the nasal bones in case of a partial depression of the bridge. *F* shows a graft extending the entire length of the bridge.

The slightest displacement of the graft may compromise the end-result. This is especially true in reconstruction of the nasal bridge. The cartilaginous support made of the proper size must be maintained in place by the surrounding skin, and it is therefore necessary to have the subcutaneous tunnel as narrow as possible.

1. These two instruments were made according to my design by the Pfau American Instrument Company.

For the safe grasping and introduction of the grafts, I constructed a forceps which serves its purpose to my complete satisfaction (fig. 2 *A*). In order to place the cartilage in the exactly fitted tunnel, the introductor must maintain a strong grip on the graft to prevent its slipping and must occupy as little space as possible. It should not be necessary to enlarge the subcutaneous tunnel because of the size of the introductor. The branches of these forceps are about from 2 to 3 mm. wide and 2 mm. thick, and the ends are provided with sharp teeth penetrating into the cartilaginous substance. The pliable branches of the forceps mold themselves over the graft (fig. 2 *B*). In depressions occupying the lower two thirds of the nose, the graft does not need to be prolonged on the upper third of the bridge, as this adds unnecessary height to the profile. To avoid tilting or curving, which is apt to produce an unsightly elevation in the middle of the bridge, the upper end of the graft should be secured under the nasal bones: the narrow branches of the introductor facilitate to a great extent the slipping of the upper end of the graft under the nasal bones and act as a periosteal elevator in separating the mucous membrane from the posterior surface of the bones (fig. 2 *E*).

AN ILLUMINATED MOUTH HOOK FOR ANESTHESIA IN OPERATIONS ON THE THROAT

GAYLORD LEWIS, M.D., WEST PALM BEACH, FLA.

In tonsillar operations the usual methods employed in the administration of ether, supplemented in some cases with chloroform, are often linked with awkwardness and inefficiency. The anesthetist is required to perform many duties at one and the same time, and frequently finds that he could very well use more than two hands. The instrument to be described greatly simplifies this procedure, increases safety and provides illumination of the throat.

The patient is etherized in the usual manner, the gag is inserted, and the lighted end of the hook is placed in the mouth as shown. The proper amount of clearance between the end of the hook and the palate is secured by slightly raising or lowering the handle of the instrument, using the teeth as a fulcrum. By a pull on the finger-holds of the hook the patient's head may be thrown into any amount of extension desired. The anesthetist holds the hook comfortably with one hand and is well out of the way of the operator, who may even stand between the patient and the anesthetist without interference. The ether and chloroform tubes and the electrical cord are all attached at the posterior end of the instrument, where they are entirely out of the way. The valves are used merely as selectors and not as regulators of the amount of flow of the gases. Regulation is done from the ether machine and from the chloroform bottle, which is provided with a rubber bulb. An electrical current is supplied from a transformer type of rheostat, which insures absolute freedom from shock or injury. Most battery handles, such as those used on small portable instruments, serve admirably in an emergency. An extra light bulb is conveniently mounted on the instrument in the event it becomes necessary to replace one quickly during an operation. I have used a single bulb, however, constantly over a period of several months without replacement. Sterilization is effected by immersion in the usual solutions or by boiling if desired.

This instrument was developed through the courtesy of the Boehm Surgical Instrument Corporation, Rochester, N. Y.

Fig. 1.—Illuminated mouth hook.

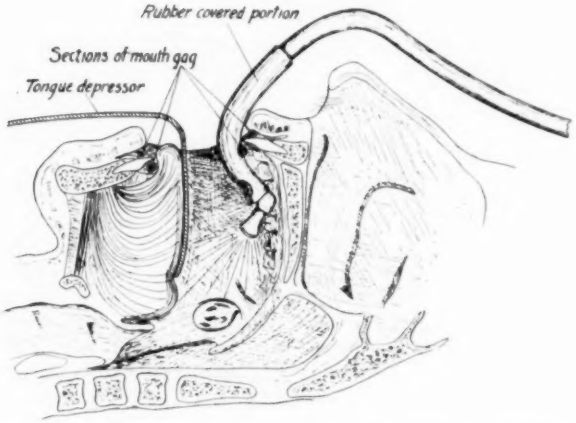

Fig. 2.—Sagittal section showing mouth hook in position.

Progress in Otolaryngology

Summaries of the Bibliographic Material Available in the Field of Otolaryngology from October, 1931, to October, 1932

ANATOMY AND PHYSIOLOGY OF THE EAR

PHILIP E. MELTZER, M.D.
AND
CHARLES N. GETTES, M.D.
BOSTON

ANATOMY

Kaji,[1] continuing his observations on the sympathetic nerve cells in the outer ear and on the relationship between their processes and the nerve fibers in the membrana tympani, demonstrated a relationship between the sensory nerve fibers of the membrana tympani such as that which exists between the motor nerve fibers and the collateral nerves. As the observations are worthy of note, a summary of the entire field of investigation is given.

On the ground of the facts stated in his report, Kaji arrived at the following conclusions:

1. The fact that the application of silver impregnation to the study of the membrana tympani has been considered extremely difficult is due to nothing more than defective manipulation of the process. If the membrana tympani is first treated with a sodium hydroxide solution of a given strength, as has been done by Schultze and Stohr, the membrane can be stained easily, and some of the successful specimens thus prepared can be used as the basis for establishing one's scientific view.

2. For the study of the nerve in the membrana tympani, it is most advantageous to use the membrana tympani of the domestic fowl. If a portion of the tissues belonging to the outer ear is cut out with the membrana tympani, the plexus of the sympathetic nerve cells existing there can also be detected. Hence this procedure is recommendable. In silver impregnation it is better to use the membrana tympani and a portion of the outer ear as a whole than to cut them into sections.

3. Besides the kind of nerve cells in the membrana tympani which are claimed to have been successfully stained by Kessel in 1870, we

1. Kaji, H.: Jap. J. M. Sc. Tr., XII., Oto-Rhino-Laryng. **1**:95 (March) 1931.

recognize the existence of nerve cells in the membrana tympani of the domestic fowl.

4. The aforementioned fibers of the membrana tympani are distributed more or less in the same sphere as those stained with methylene blue (methylthionine chloride, U.S.P.) by Kessel and other authorities; that is, the nerves in the membrana tympani chiefly enter the membrane through its periphery, and ramify into two or three branches mostly at acute angles, thus reaching the central part of the membrane. Among them are nerves which run at an angle of 180 degrees, but when observed carefully, the angle of ramification is found in most cases to be acute. The positions of the nerves can be roughly classified according to the strata in which they are found, as under the layer of epithelial cells and in the plexus in the layer of the lamina propria. The former two sometimes become united in the lamina propria. The pars flaccida abounds more in nerve fibers than the pars tensa.

5. The nerve endings do not present a leaflike or knotted form as stated by some authors, but assume the type of free ending or of pinhead termination that is seen in the cornea.

6. If an incision is made in the peripheral region of the membrana tympani, degenerating phenomena are seen in the terminal nerves corresponding to the incised nerves, the degree of these changes being proportionate with the lapse of time after the incision.

7. In the course of the nerves in the membrana tympani, there are small collateral nerves such as those described in connection with the motor nerve. These collateral nerves seem to arise from the sympathetic nervous system, which forms a plexus of nerve cells in the subcutaneous region of the outer ear. They seem to end, like the cerebral nerves, among the cells, structureless or with pinhead enlargements.

8. There are two types of nerve cells in the sympathetic nerve plexus in the hypoderm of the outer ear, especially near the outer ring of the membrana tympani, namely, the stellate and the oblong cells. They send their respective fibers into the membrana tympani, some of which seem to become the aforementioned collateral nerves.

Truffert,[2] discussing the anatomy of the attic, states briefly that the walls are constituted as follows: the superior wall, by the tegmen tympani; the posterior wall, by the aditus ad antrum, together with the subjacent region, including the pyramid. The internal wall is a triangle truncated by the labyrinthine wall of the drum; its lower limit is marked by a line starting from the lower edge of the pyramid and encircling the lower circumference of the fenestra ovalis. No anterior wall exists. The external wall in its lower portion consists of the membrane of

2. Truffert, P.: Oto-rhino-laryng. internat. **16**:115, 1932.

Shrapnell; the upper portion is furnished by the submeatus or the mechanism of the ossicles.

The lower wall of the attic is conditioned by the fact that the ossicles are not in the drum any more than the intestine is in the peritoneal cavity. Primarily parietal, the ossicles represent the cranial insertion of the first two branchial arches. When the middle ear is formed in the course of development, the whole process occurs as pharyngeal evagination, coming from the eustachian tube, penetrating into the middle ear and aerating it. The evaginating budding insinuates itself into all the free spaces and covers the ossicles together with their vestigial muscles and ligaments or their vascular tracts, thus constituting the middle layer of these organs. The mucous evagination, penetrating by the tubotympanic orifice, encounters the tympanic membrane, which it completes; it then extends up about the neck of the malleus, and, encountering the tendon of the malleus muscle, continues its evolution between this tendon anteriorly and the mass of the ossicles posteriorly. At this level the evagination has already encountered the chorda tympani, which it covers with a middle layer, and together with the ligaments of the malleus constitutes Troeltsch's spaces. Truffert traces the continuation of the middle layer throughout the formation of the attic. Its continuity is indisputable. However, as in the peritoneum an avascular zone of serous middle layer can present phenomena of resorption, so the mucous middle layers of the drum show similar resorptions. A phenomenon of resorption is responsible for the communication described as frequent between Troeltsch's posterior space and Kretzschmann's cavity. If, anatomically, the septum of the drum is complete, pathologically, the attic has a right to an equal autonomy. A slight infection from the drum affects the attic if it reaches Prussak's space; inflammations or perforations of Shrapnell's membrane will be seen otoscopically. However, such an infection may reach and establish itself in the subtympanic cavity, affect the suprameatic or zygomatic cell groups, and exteriorize itself around these cells, without ever having presented any clear otoscopic signs.

Dubreuil and Valette,[3] in a study of the vasosensory apparatus of the nose, eyes and ears, by which they mean the specialized venous reticuli in the sensory zone of the sensory organs, the rôle of which it is to maintain a temperature favorable to the reception of excitations, conclude that there is no such apparatus in the internal ear, whereas it does exist in the other organs named. While the modiolus is abundantly supplied with arterioles, capillaries and venules, it is without specialization. Nevertheless, the presence of numerous and dense capil-

3. Dubreuil, G., and Valette, M.: Compt. rend. Soc. de biol. **107**:344, 1931.

laries in the superficial zones of the modiolus near the spiral ganglion and in the vascular streak of the cochlea must be noted. More numerous vessels than anywhere else are also present around the maculae acusticae and the crista ampullaris, but there is no special venous apparatus.

The vascular plexus, which supplies the complex apparatus of the internal ear, completely studied in its morphology by Siebenmann and by Nabsya, presents in its arterial portion a peculiarity which attracted the attention of Winiwarter and was described in its relations and its situation by Schwalbe. The branches of the cochlear artery and the cochlear branch of the vestibulocochlear artery in their course in the modiolus of the cochlea show well marked convolutions, described by Schwalbe as cochlear arterial glomeruli. Malan [4] studied the arrangement, the finer structure and the relationship of the glomerular vessels to the bony framework, in the cat and in the dog, in specimens fixed in a bichromate-acetic acid-formaledhyde solution enclosed in pyroxylin (celloidin), some stained and others unstained. The tortuous vessels were followed up in serial specimens, including the entire labyrinth, and their existence could be shown not only in the cochlear modiolus, in the spiral limbus and between the gyrations of the cochlea, as described by other writers, but also in the substance of the perilabyrinthine bone and precisely in its segments traversed by the ramifications of the acoustic nerve. Arterial glomeruli similar to but less tortuous than those which accompany and surround the cochlear nerve are demonstrable in the same relationship around the other branches of the acoustic nerve, so that the arterial glomeruli do not belong exclusively to the cochlear artery and to the cochlear branch of the vestibulocochlear artery, but also to those branches of the vestibular artery and of the vestibulocochlear artery which pass to the other portions of the membranous labyrinth, through the route followed by the nerve. In his study of the finer structure of these arteries, Malan showed that the so-called glomerular arteries have a distinctly different structure as compared with that of other organs of approximately equal caliber. Their walls are relatively thin, not much thicker than those of the veins of the same vascular domain, but they are of a larger caliber and are characterized by cells in the adventitia, probably identical with the adventitial cells of Marchand. The arterial wall presents an endothelium with cells protruding into the lumen; directly underneath, a relatively well marked, fine membrane is seen, with annular fibers arranged vertically to the axis of the vessel. This membrane seems to replace the normal elastic membrane, which is not positively recognizable. On its exterior, smooth muscle cells are often seen irregularly arranged oblique and vertical to the axis of the vessel, similar to the contractile cells of the capillaries

4. Malan, E.: Boll. d. Soc. ital. di biol. sper. **6**:832, 1931.

(Rouget cells). The very small capillaries derived from these arteries have a structure similar to the glomerular arteries, with a thin fibrillar membrane, which is characterized by its very fine, closely arranged annular fibers. These fibers are stained by the Achucarro method and are not positively demonstrable by ordinary methods. On the basis of this observation, they seem to belong to the so-called reticular fibers. As already stated by Winiwarter, all these vessels are surrounded by a loose connective tissue, which fills the interval between them and the osseous wall. On closer study, this tissue appears similar to embryonic mesenchyma, through the presence of cells of mesenchymal type with scanty cytoplasm and irregular ramifying processes, with very few collagenous fibers. These characteristics, more particularly the scarcity of collagenous fibers, approximate it more to the embryonic mesenchyma than to the mucous tissue of the umbilical cord. During the study of these peculiar formations, Malan, by means of the Achucarro method, was able to see osseous tissue with intricate fibers limited to the zone of the arterial glomeruli, while in the directly contiguous zones the bone had a lamellar structure. The most noteworthy fact is that the osseous tissue here differs from the ordinary fibrous osseous tissue which exists in the embryo, through the thickness of its fibers and because of its complicated reticular anastomoses. Its constant relationship with the glomerular vessels and with all the branches of the acoustic nerve must be emphasized. Kolmer and Cipollone interpreted the glomerular vessels as an attenuating apparatus for the endogenous vibrations and particularly for the pulsatory impetus which may be propagated to Corti's organ. It seemed probable to Malan that this interpretation is in conformity with the truth. But perhaps this theory should be modified, keeping in mind Malan's demonstration of glomerular vessels not only in the modiolus of the cochlea, but also in the vestibule near the maculae acusticae and the acoustic crests.

Massione,[5] after a brief survey of modern data on the anatomy and physiology of the saccus endolymphaticus, describes a series of experiments on animals, for the most part pigeons, for the purpose of ascertaining whether liquids injected into the endolymph will pass into the cerebrospinal fluid, or, vice versa, from the latter into the labyrinth. The laboratory animals were given injections of solutions of indigo carmine or methylene blue as well as of opaque fluids (solutions of iopax and sodium iodide), and the solutions were seen to pass readily from the labyrinth into the interior of the cranium; it was impossible to demonstrate the passage of the fluids from the cerebrospinal fluid into the endolymph. Under these circumstances, the substances injected were never found again in the labyrinth. These in part positive results

5. Massione, Guisseppe: Riv. oto-neuro-oftal. **8**:255, 1931.

are contrary to the present knowledge concerning the anatomy of the saccus endolymphaticus, which shows no visible communication between the labyrinthine cavity and the subdural spaces; so that the labyrinth has come to be considered as a closed cavity. Massione is inclined to question the value of the results obtained by him and considers further control experiments necessary for the verification of his findings. Any positive proof of easy communication between the labyrinth and the cerebrospinal fluid would naturally be of great importance from the point of view of the physiology and pathology of the labyrinth.

Massione concludes from these investigations that the saccus endolymphaticus is readily permeable in the direction from the endolymph to the cerebrospinal fluid, but not so in the opposite direction. The passage of the fluid in the first direction takes place so rapidly that diosmosis can practically be left out of consideration. Nevertheless, in spite of the minimal amount of the slowly injected fluid, Massione does not entirely repudiate the possibility that microscopically small ruptures may eventually have been produced through the injection into the membranous labyrinth, so that further control of his findings is required.

Francesconi [6] points out that the centripetal route derived from the peripheral vestibular organ, on penetrating into the bulb, promptly divides into two parts, one which is known as the bulbocortical route, and the other as the bulbocerebellar route. The former is continuous with the main, dorsal or triangular vestibular nucleus, at its descending portion and at the nucleus of Bechterew (posterior vestibular nucleus). These nuclei are known to be exclusively composed of small cells of sensory somatic type. The second portion is continuous with the nuclei of the roof of the cerebellum and consists of cells similar to the sensory somatic cells. The fact that the Bechterew nucleus is composed exclusively of small cells of sensory somatic type indicates that motor stimuli are given off directly from this nucleus, which by way of the posterior longitudinal bundle reach the mesencephalic motor nuclei. It is becoming progressively more probable that Bechterew's nucleus is part of the sensory route, and that from it it passes to the Deiters nucleus, the stimuli from which are distributed to the mesencephalic and spinal oculogyric and cephalogyric nuclei. Also, according to P. van Gehuchten, who excludes Deiters' nucleus from the terminal nuclei of the vestibular nerve, direct fibers pass from Bechterew's nucleus to the mesencephalic nuclei. The sensory stimulus, on reaching the neurons of the triangular nucleus and Bechterew's nucleus, must pass to the cells of the so-called Deiters nucleus, these cells usually being large and of motor type,

6. Francesconi, G. Lippi: Riv. sper. di freniat. **55**:358, 1931

belonging to the extrapyramidal motor system. This system gives off motor stimuli for the spinal cord by way of the incorrectly named vestibulomedullary route, more correctly Deiters' medullary route, and through the mesencephalic nuclei to Deiters' mesencephalic route or the vestibulobulbomesencephalic route, which precisely unites Deiters' nucleus with the nuclei of the oculomotors, in order to invest these nuclei with the kinetic tonus, in the sense of Ramsay Hunt. The sensory stimulus, conveyed instead through the inferior cerebellar nuclei to the nuclei at the roof of the cerebellum (small sensory somatic cells), then passes to the cells of the dentate nucleus, which is known to belong likewise to the extrapyramidal motor system (Lewy). From the dentate nucleus, motor stimuli pass through the mesencephalic, bulbar and spinal masses, through the route of the superior cerebellar peduncle (vestibulocerebellomesencephalic route), conveying the static tonus, in the sense of Ramsay Hunt. From all the various nuclei, crossed and direct fibers are given off, but their courses vary according to the nuclei. The fibers derived from Bechterew's nucleus and the triangular nucleus pass chiefly to the red nucleus of the same side; those from Deiters' nucleus pass chiefly to the red nucleus of the other side. It accordingly follows from these experimental investigations that the posterior longitudinal bundle in the dog represents a route which connects the vestibular nuclei not only with the nuclei of the ocular muscles, but also with the static centers of the mesencephalon. With great probability it follows from all these considerations that the vestibulolongitudinal tract is to be regarded as the afferent route of the reflex arc of the labyrinthine static reflex.

The four types of vestibulo-oculomotor connection are as follows: 1. There is a direct connection between the second sensory neuron and the first motor neuron of the ocular route. 2. A connection of secondary type exists between the second sensory neuron, Deiters' nucleus and the oculomotor nuclei. 3. There is a connection of tertiary type by way of the thalamus (Winkler), exerting an action on the nuclei of the ocular muscles by means of fibers derived from the pedicles passing in a downward direction in the posterior longitudinal bundle (L. J. Muskens). By way of this system occurs the kinetotonic innervation. The statotonic innervation takes place by way of the dentate nucleus, connected with the second neuron of the vestibular route, situated in the nucleus of the roof, and by way of the cerebellum, the cerebellar, red nuclear route and the red nucleus-Deiters'-mesencephalobulbospinal route. 4. The cortical centers of conjugate deviation are connected by way of the optic thalamus and the thalamocortical radiations.

HISTOLOGY OF THE EAR

Nager and Meyer,[7] from a detailed study of the normal and the pathologic histology of the osseous capsule of the labyrinth, conclude that probably the blue color of a portion of osseous tissue in otosclerosis is caused by a large amount of putty substance or intermediate bone substance. Labyrinthine bone, containing fibers but no lamellae in a normal labyrinthine capsule, forms the greatest part of the bone of the enchondral capsule. Small amounts of it are found also in the periosteal capsule. This bone contains numerous fibrillae and relatively little putty substance. Even after preliminary complete decalcification, it is stained intensively red in a specimen stained with hematoxylin and eosin. Lamellar bone is present in small amounts in the enchondral capsule, but a larger amount is found in the medullary spaces of the periosteal capsule. It contains more or less thick layers of putty substance between the lamellae and is stained blue or blue-gray. Great local and individual variations are found in the plexus-like bone so far as the ratio of fibrillae to putty substance is concerned; usually the latter predominates. The plexus-like bone is usually basophilic; in other words, it is more intensively stained with hematoxylin than with eosin and is bluish purple or gray. The conclusion is permitted that in deep blue osseous tissue in pathologic cases a large amount of calcified putty substance must be present, independent of the kind of osseous tissue that is found. Theoretically, a deep blue bone may have a plexus-like or lamellar structure, or it may contain fine fibrillae but no lamellae; only the ratio of calcified putty substance to fibrillae determines the color. Various transitions may be observed between the deep blue color of the putty line containing no fibrillae and of the lining of the osseous cavities and blood vessels on the one hand, and the pale pink color of the osteoid tissue not yet containing calcium on the other hand. The various colors of the labyrinthine capsule in specimens stained with hematoxylin and eosin permit no conclusion without control by other methods. Old labyrinthine bone is usually more intensively stained red than osteoid tissue, but in many cases the difference is very slight and only a morphologic demonstration of calcium granules permits a definite conclusion. Usually no lamellar bone is found in the enchondral capsule. When such bone is found in polarized light or with the method of staining the fibrillae, the conclusion is permitted that this bone has been newly formed. Soon after its formation, the lamellar substance appears darker blue than the surrounding tissues. Exact diagnosis is more difficult in the periosteal capsule than in the mastoid process, because lamellar substance is found in this region under normal circumstances.

7. Nager, F. R., and Meyer, M.: Beitr. z. Anat., Physiol., Path. u. Therap. d. Ohres **29**:158, 1931.

After complete calcification, it is usually stained weak blue; pink or bright red lamellae may be interpreted as new formations with a lack of calcification or a partial calcification.

EMBRYOLOGY

Bast,[8] concluding his study of the development of the otic capsule, summarized as follows: 1. The growth of the semicircular canals takes place within a mass of cartilage which surrounds, lies between and is included within the arcs of the semicircular canals. The expansion of the canals involves two processes: (*a*) an extensive destruction of cartilage between and within the arcs of the canals by necrosis and extensive connective tissue ingrowths, and (*b*) a regressive dedifferentiation of cartilage at the advancing margin and a building of cartilage at the receding margin of the canals.

2. Removal of cartilage is accomplished by monocytes or histiocytes which enter the cartilaginous capsule within the ingrowing connective tissue buds.

3. The canals reach their approximate maximum growth at about half term, or at the time when their capsule begins to ossify. The exact time varies in the three canals. The superior canal reaches its maximum growth in fetuses of about from 150 to 160 mm. in crown-rump length; the posterior canal, in fetuses of about 180 mm., and the lateral canal, in fetuses of about 200 mm.

PHYSIOLOGY OF THE MIDDLE EAR

Caussé,[9] in an analysis of the work of J. Helsmontel and F. Nyssen, and on the basis of recent publications, discusses the cochleovestibular reflexes and the reflectivity of the ossicular muscles. Regarding the latter, he says that the only objective phenomenon which can be qualified as a reflex is the contraction of the tensor muscle of the tympanic membrane and that of the stapedius. The muscle of the malleus, the tensor tympani, which is much more voluminous and more accessible than the muscle of the stapes, lends itself much better to experimentation, owing to the displacements produced by it in the tympanic membrane. By means of fixation to the tympanic membrane of a very small mirror, on which falls a thin ray of light, Kohler was able to register the vibrations and the displacements of this membrane. They can also be observed directly by means of a special microscope like that of

8 Bast, T. H.: Development of the Otic Capsule: I. Resorption of the Cartilage in the Canal Portion of the Otic Capsule in Human Fetuses and Its Relation to the Growth of the Semicircular Canals, Arch. Otolaryng. **16**:19 (July) 1932.

9. Caussé, R.: Ann. d'oto-laryng. **5**:546, 1931.

Einthoven. These procedures have shown that under the influence of a sound stimulus the tensor tympani becomes tetanized and remains in this condition during the entire duration of the stimulation. The higher the sound and the more unpleasant and intensive it is, the more readily does the reflex contraction appear. Another important point is the fact that this reflex contraction is not constant; there are normal persons who do not present it. These findings are identical in animals. Kato, who has studied and registered the reflex contraction of this muscle in a large number of animals, has shown that there are species in which the phenomenon does not exist, for example, the guinea-pig and the monkey. On the other hand, the rabbit reacts in an extraordinary manner, for it is sensitive to stimulations varying from 64 to 50,000 double vibrations.

Credit is likewise due to Kato for precise data on the function of the stapedius muscle. As opposed to the tensor tympani, this muscle presents contractions in all animal species. Until the last few years, it was not possible to verify in man the phenomenon discovered by Kato, which so directly opposes the stapedius to the tensor tympani muscle. Recently, Luscher observed a person with normal audition who presented a traumatic perforation of the tympanic membrane, so that inspection of the stapedius muscle by means of an auricular microscope was possible. Identical demonstrations could be made in another case. Luscher was thus able to confirm the law formulated by Kato, namely, the constancy of the cochleostapedial reflex. This reflex appears for all the tones of the auditory scale perceived by the subject. For a soft tone, there is only a single and rapid contraction; but in proportion as the sound becomes more intense, the contraction lengthens and is finally transformed into a physiologic tetanus. Noises are more efficacious than tones, as though the human ear was more receptive for noises. Conversational speech at 50 cm. gives a very evident reflex. Unlike the tensor tympani, the stapedius cannot contract under the influence of the will. The imminent expectation of a violent noise may elicit the reflex. But the most curious phenomenon demonstrated by Luscher is that designated by him as reflex deafness. When a sufficiently intense and prolonged sound is emitted, averaging a minute and thirty seconds, the muscle loses the faculty of contraction, but the exhaustion of the reflex applies only to the emitted tone, while the reflectivity is preserved for all the other tones. Several minutes are required for the restoration of the electively suspended function of the muscle. The action of the stapedius thus seems closely connected with the cochlear function. Hence it may be justifiable here to speak of a "cochlear reflex." But it is a question whether it will ever be possible to utilize this phenomenon for clinical purposes.

Kobrak,[10] delving once more into the study of the physiology of the internal muscles of the middle ear, states: It can be demonstrated experimentally that during the act of hearing the internal muscles of the ear are in a state of contraction, which may be observed and registered. In harmony with Kato, it may be observed that weak stimuli do not stimulate the muscles, strong stimuli lead to a contraction of the stapedius only, and still stronger acoustic influences lead to a contraction of both muscles. The contractions are of a tetanic type, and are of the same duration as the stimulus. The degree of contraction is adjusted to the physical properties of the stimulus (intensity of the sound and frequency relations between the acting stimulus and the tone of the sound conduction chain). These physical properties determining the muscular contractions are designated by us as "quanti-valences" of the stimulus.

The effect of the internal muscles of the human ear was analyzed in preparations of the petrous portion of the temporal bone. The preparations were treated as an acoustic registration apparatus according to the method of Frank, and the influence of the muscles on this system was studied. A change in the sensitiveness could be demonstrated under the influence of the tensor tympani and stapedius muscles; both muscles decrease the sensitiveness. The tensor tympani especially interferes with the movement of the malleus, while the stapedius interferes with the movement of the stapes. The sound conduction chain represents a conduction apparatus of the following construction: 1. High sensitiveness is present. 2. The most important stimulating frequencies are in resonance with the tone of the sound conduction chain proper. 3. The damping is situated between 0.3 and 0.4.

The functions of the internal muscles of this system may be considered as follows: (1) variation of the sensitiveness in the sense of a protective effect; (2) partial correction of the registration errors in the resonance region; (3) change in the amplitude relations of the ossicles; (4) essentially the same resonance curve, in spite of the variation of the sensitiveness.

Politzer and others were of the opinion that the purpose of the muscles was to equalize large variations in pressure in the tympanic cavity. This view is refuted by Kobrak and his co-workers, since, as stated, they were able to show that the normal acoustic stimulus gave rise to contractions of these muscles, and that the contractions ceased with the cessation of the stimulus, thereby decreasing the sensitivity of the sound conduction chain.

10. Kobrak, H.: Beitr. z. Anat., Physiol., Path. u. Therap. d. Ohres **29**:383, 1932.

In collaboration with his colleague, van Egmond, Quix [11] began a threefold study: 1. They determined by what routes the fluid substances which can be introduced into the middle ear of animals penetrate into the internal ear and what route they follow in the internal ear. 2. They investigated in various cases whether fluids injected into the blood current penetrate into the internal ear, and, if so, what route they follow therein. 3. They are engaged in an investigation, in part already carried out by other investigators, to determine whether fluids introduced into the cerebrospinal space penetrate into the internal ear. The first series of investigations has been completed and is discussed in this contribution.

In guinea-pigs, fluids (cocaine and colored salts) injected through the tympanic membrane, unilaterally or bilaterally, penetrate into the labyrinth, not by way of the labyrinth windows, but by way of the bony wall. The substances injected disappear again from the labyrinth along the lymphatic vessels, but do not pass centrally along the nerves to the brain. The outcome of other experiments on guinea-pigs indicated that Corti's organ is destroyed through the substance injected, whereas the cristae and maculae promptly become normal. This results because anatomically no blood vessels are found in Corti's organ. The poisoning of the endolymph which nourishes the organ promptly destroys it. On the other hand, when not the sensory cells but the innervating nerves are attacked, the maculae and cristae suffer less through the poison, and furthermore they are mainly supplied by blood vessels, which guard against necrosis.

The fluids injected into the middle ear remain demonstrable therein for only a few hours, and then rapidly disappear along various routes.

COCHLEAR PHYSIOLOGY

Meyer [12] states that the contention that sound enters by the round window or the oval window is fictitious. Physiologically speaking, sound does not enter the cochlea. The work done in the cochlea results from the instantaneous difference in pressure between the windows. The difference in pressure is greatest at the instant when the density of the external air is changing most rapidly; it is zero when the density happens to be either at its maximum or at its minimum.

Furthermore, Meyer continues: "There are two quite independent causes of a pressure between the windows—1, air conduction—2, bone conduction." These two terms are not well chosen from a concept of physical principles. The fluid in the cochlea must move when there is an instantaneous difference in pressure from one to the other window.

11. Quix, F. H.: Nederl. tijdschr. v. geneesk. **75**:4382, 1931.

12. Meyer, M. F.: Ann. Otol., Rhin. & Laryng. **41**:323 (June) 1932.

as is usual in the noisy world and again when the vessel is "shaken." The oval window is loaded with a heavy weight made up of stapes, incus and malleus (the tympanum), whereas the round window is free from any intrinsic load. This load causes a lag or a phase difference. Quoting Bárány's experiment, in which a drop of mercury in the region of the niche to the round window was productive of improved hearing because the load at this point was increased, Meyer corroborates this fact and contends that bone conduction and air conduction are inseparable sources of stimulation, and that the essence of stimulation is unitary, a mere phase difference between the windows. The cochlea serves as an analyzer by its simple anatomic properties made hydraulically effective. Meyer points out that either kind of phase difference, therefore, is the essence of sound stimulation, and if the otologist wishes to increase the susceptibility of his patient's ear to stimultaion, he should remember these statements.

Crowe and Hughson [13] direct attention to a test by which Wever and Bray were able to reproduce sounds that enter the ear of an animal. One electrode is introduced into the auditory nerve, or brought near it, and the other electrode is introduced into the muscles of the neck. An amplification apparatus and a loud speaker are joined into the circuit. Wever, Bray and others employed this method for investigations on the action currents and on the localization of the cerebral auditory centers; however, Crowe and Hughson found it helpful in determining the normal function and physiopathology of the auditory apparatus. This test makes it possible to study every structure of the middle and internal ears, the modification of the transmission of sound by localized lesions of the tympanic membrane, of the auditory ossicles, of the membrane of the fenestra rotunda and of the tensor tympani and the stapedius muscles, and the changes in intralabyrinthine pressure. Following preliminary tests that corroborated the results of Wever and Bray, the authors made tests on those portions of the ear which are active in sound conduction. Experiments on cats showed: 1. The removal of the external ear or the obstruction of the external auditory meatus reduced the intensity of the sound considerably. These portions obviously effect concentration of the sound on the auditory apparatus. 2. An incision into the tympanic membrane does not impair the transmission of sound through the middle and internal ears. If such an incision is followed by a reduction in the transmission of sound, some structure in the middle ear has been injured. 3. For the conduction through the middle ear it is necessary that the chain of the auditory ossicles is intact. Changes in the incudomalleal joint or in the incudostapedial

13. Crowe, S. J., and Hughson, W.: Ztschr. f. Hals-, Nasen- u. Ohrenh. **30**:65, 1931.

articulation make conduction impossible for all sounds of less than 4,096 double vibrations. 4. A certain tension of the tensor tympani prevents the conduction of all spoken words and of pure tones up to 2,048 double vibrations; but as soon as the tension relaxes, the conduction becomes normal again. Division of the tensor tendon at the site of attachment on the malleus effects, after an interval of ten days, a considerable reduction in the intensity of all tones of over 1,024 double vibrations, whereas sounds within the range of the normal voice remain unchanged. 5. Pressure on the membrane of the fenestra rotunda of anesthetized cats increases the clearness and the intensity of the sounds of the speaking voice and of all pure tones between 512 and 4,096 double vibrations. This manifestation is noticeable in normal as well as in pathologic ears. The membrane of the fenestra rotunda evidently acts as a safety valve for the protection of the structures of the internal ear. As a result of its mobility, it absorbs a large percentage of the sound impressions.

Tullio,[14] in a study of the physical bases of auditory sensation, attributes to sound vibrations three fundamental qualities: (1) duration, (2) ampleness and (3) direction.

These qualities of sound are analyzed by three different parts of the ear, that is, the cochlea, the saccules and the semicircular canals. The basilar membrane is found within the cochlea and is formed of fibers which are arranged in one direction only and can easily be separated from one another. They thus form a series of resonators. The faculty of perception and distinction between sounds depends on elective transmission of motion through elastic means from one vibrator to another, which must vibrate and oscillate with the same rhythm. Tullio ascertained the effects of sound on the membrane experimentally, and for this purpose used a thin elastic membrane which was distended in the form of a trapezoid between two rectilineal supports. Helmholtz found that the basilar membrane has the least tension in the direction of the grain and a maximum tension in the direction of the fibers. The author cut the elastic membrane into very fine parallel stripes arranged in the form of the keyboard on a piano. He used an Edelmann whistle, and found that according to the pitch of the sound the cords moved in various parts of the membrane. If the sound is not interrupted and the wavelength is increased or shortened, the motion is transmitted without interruption from one cord to another. Illumination of the membrane showed sympathetic vibration. Some of the cords, especially those with a lower pitch, were pushed back by the sound, while others of a higher pitch were attracted by the sound. These experiments have been tried frequently and represent nothing new. The different experi-

14. Tullio, P.: Oto-rino-laring. ital. **2**:1, 1932.

ments showed that the sounds receive pitch, and their union into melodic and harmonious series takes place, in the cochlea. Music, according to this theory, is nothing but a mental elaboration in human beings. The cochlea performs also a much greater task; that is, it distinguishes between innumerable sounds. It may be assumed that sounds are produced by any body which is set in motion. The sounds have a different timber. It is known to everybody that the sound of money is different from that of crystal or of other hard substances. These sounds resound on the basilar membrane, producing different spectra which are characteristic for each substance.

The acoustic saccules are located in the vestibule of the ear. They are round and in some animals are almost spherical. The range of sound is analyzed in this part of the ear. Experiments which were made in this connection showed how the different vibrations changed the form of droplets, causing contractions and expansions. Motion pictures showed that a true vortex is produced by the sounds. It is interesting to note the motion of the vortex or circular current and its attraction by the sound. The vibrations which animate the small particles in motion are more or less rapid, and the currents follow exactly every modification of intensity of the sound. The observations which Tullio made are in accordance with the newest theory of undulation of all mechanical forces. The currents form in the liquids in proximity of the vibrating bodies in the direction in which the sound moves. These currents may be noted not only in the periphery, that is, in the vestibule, but in the endolymph, where they form a vortex the principal axis of which is arranged in the same direction as the sound. The endolymph is located in the utricle, and this in turn is connected with the three semicircular canals. A current which occurs in the interior of these canals produces a movement of the eye, head and body at the level of the canal, which is arranged in three layers in all animals. The perception of the sound also indicates at the same time its location and therefore has been called the directing acoustic reflex. In times past the perception of sounds and the origin of speech were attributed to the saccule and utricle. Tullio experimented in this connection and found from different palpitations in the utricle of a pigeon that this assertion was based on fact.

Maffeo [15] reviews the following principal theories of audition: the theory of Cotugno-Helmholtz; the hydrodynamic theory (Bonnier); the Ewald theory; the Cheval theory, or the theory of selection of sounds, and the resonance theory. The acoustic resonance, according to Bonain, is the very essence of audition, which might be defined as the sensibility of the auditory sensory elements induced by means of the

15. Maffeo, L.: Morgagni **74**:196, 1932.

secondary vibrations generated by the sound waves on coming in contact with the membranous resonators of Corti's organ. According to this theory, audition is assumed to occur through a simple resonance phenomenon, or a secondary vibration phenomenon, not as meant by Helmholtz and as still assumed with some detail modifications by A. Gray and G. Wilkinson. Physiologists and otorhinolaryngologists have raised a series of objections against the old Cotugno-Helmholtz theory. The elective and exclusive affinity of certain fibers, certain striae or certain strings for a definite sound is rather imaginative and cannot successfully resist closer criticism. The majority of writers also do not endorse the ingenious ideas of Cheval, although they are supported by numerous and accurate calculations. As a matter of fact, although the calculations of this writer, establishing a mathematical relation between the velocity of the transmission of sound in the segments of the labyrinth and the length of the basilar membrane, may apply to the adult (granting that this membrane has a length of 25.5 mm.), these calculations would be entirely inaccurate in the child, who, although in possession of perfect hearing, presents an internal ear of extremely small dimensions. There is good reason to believe that auditory perception is a much less complex phenomenon than is usually supposed. The majority of physicists and physiologists now believe that this phenomenon is of extreme simplicity. Whether there are, as assumed by Bonnier, oscilations of the labyrinthine medium under the influence of sound vibrations, or whether there are, as stated by Bonain, resonance phenomena developing in the cochlea, there finally exists an impetus which stimulates the specific element of the internal ear, namely, the acoustic papilla. This structure in turn transmits the sensation to the brain, in proof of the fact that the auditory perception takes place in the cortical centers.

Hughson and Crowe,[16] utilizing the Wever-Bray technic for accurately measuring the intensity of sound impulses transmitted through the cat's ear, and with a standardized experimental technic, confirmed the theory of increased intensity produced by packing the niche of the round window with pledgets of cotton.

Furthermore, an operative procedure was developed whereby the membrane of the round window of a cat's ear can be immobilized with a periosteal graft. The result of such immobilization is a great increase in the intensity of spoken voice and tones transmitted through the ear operated on, provided the foot-plate of the stapes is intact.

At the end of the sixteenth century, Fabrice wrote: "The tympanic membrane transmits the vibrations which it receives and communicates

16. Hughson, W., and Crowe, S. J.: Ann. Otol., Rhin. & Laryng. **41**:332 (June) 1932.

them to the chain of ossicles as well as to the cavity of the drum. Sharp sounds are transmitted by the stapes to the fenestra ovalis; dull sounds, to the fenestra rotunda." Nothing different from this is said to this day, except that the fenestra ovalis is classically considered as assuring the transmission of all sounds. The fenestra rotunda plays only an effaced rôle; its supple membrane deadens the decompression or detains the labyrinthine fluids created by the movements of the oval membrane. However, this well established physiologic concept of transmission by the chain of ossicles has been attacked by certain otologists. Vieussens has never accepted it, and he states that it is the air of the drum which plays the rôle of agent of transmission, while the fenestra rotunda transmits the tympanic vibrations to the inner ear. Bonain has recently defended this opinion, and certain of his arguments are impressive.

Bertein,[17] in presenting a review of the transmisison of sounds, gives four considerations:

1. Physically, it is the concussion of the molecules that compose the membrana tympani (itself remaining immobile) which assures the habitual transmission of sounds. The chain of ossicles does not lend itself, however, to this transmission of molecular vibrations.

2. Anatomically, the fenestra rotunda is the shortest route leading from the tympanum to the inner ear. The round window, exposed directly to sonorous influences and sheltered by the promontory from certain excesses of sound, opens on the tympanic canal of the cochlea and the organ of Corti. On the contrary, the fenestra ovalis, situated higher and above the promontory, opens at the entrance of the vestibular canal. Thus, it would be by a devious route, on which the sacculus raises still another obstacle, that sounds transmitted by the fenestra ovalis would reach the inner ear, losing part of their force en route.

3. Clinically, further proof that the ossicles are not indispensable to the transmission of sound is observed every day in the examination of patients with chronic otitis in whom suppuration has destroyed the tympanum and has emptied the drum of its contents. These patients do not all complain of poor hearing.

4. Experimentally, sound traumatism in animals was first done by Wittmaack, and it has been reproduced a number of times. The experiments were performed for the purpose of determining the pathologic anatomy of professional deafness (such as the deafness of artillery men and of coppersmiths). The only portion of the experiments here discussed is the invariable absence at autopsy of the animals of any alteration of the vestibular organs or their nerves or ganglions. How can this integrity of the vestibule be explained if one

17. Bertein, P. E. H. F.: Arch. de méd. et pharm. mil. **94**:129, 1931.

believes in the transmission of sounds by the ossicles and the fenestra ovalis, which, as has been shown, has direct relations with the vestibule? The otophysiologists consider the ossicular apparatus and its musculature as an organ exclusively of accommodation. It would thus be a perfectionating apparatus added to the auditory apparatus, which is infinitely less differentiated than that of the eye. This is a return to the conception of Willis, making an entire comparison of the ear and the eye: the former refracts sound waves as the latter does light waves. In anatomy, the drum is called a bicornate lentil; this is also true physiologically, a lentil with a double effect: Under the action of the chain of ossicles and the two antagonistic muscles, the tympanic membrane and that of the fenestra rotunda bulge out or become hollow, sometimes opposing their concavities to make poorly penetrating sound waves converge and render them more audible. Sometimes, on the contrary, they back their convexities together to diverge the sound waves and diminish the energy of intense sounds or of high tonalities, thus protecting the perceiving organs. The stapedius muscle thus becomes the converger muscle, and the malleus muscle, the diverger muscle.

This conception is possibly too imaginative. It indicates, as simply as possible, the essential elements of the arguments of those who consider that the fenestra rotunda plays the capital part in the physiology of the transmission of sound. At present, although it is admitted that the fenestra rotunda is much more important than is traditionally considered in the transmission of sound, it does not seem to be necessary to give up the classic belief in the chief importance of the ossicles and the fenestra ovalis.

NYSTAGMUS

Lorente de Nó,[18] in a detailed monograph of 169 pages wherein he presents a study of nystagmus in the light of present-day physiology, gives the following data. In the general discussion of the characteristics of nystagmus, especially as related to the amplitude, frequency and duration, he found that they are dependent on the central nervous processes. It has frequently been asserted that direct connections exist between the so-called amplitude plane of the nystagmus and the stimulated semicircular canals. Such a view is no longer tenable on the basis of present-day knowledge. Numerous investigations have demonstrated that following rotations with a rapid beginning, which are continued with decreasing subthreshold rapidity as far as rest, no postrotatory nystagmus develops. Such rotations the author terms physiologic rotations, corroborating M. H. Fischer's findings in man, because they are made use of under ordinary living conditions.

18. Lorente de Nó, R.: Ergebn. d. Physiol. **32**:73, 1931.

Unilateral extirpation of the labyrinth causes ocular nystagmus to the healthy side and ocular deviation to the side operated on. The rotation reflexes are modified. A certain asymmetry of the rotation nystagmus is especially noticeable. The nystagmus to the healthy side produced by rotation appears stronger and more protracted than the nystagmus toward the side operated on. One could regard this manifestation as a confirmation of the law of Ewald. Lorente de Nó expressed the view that an ampullopedal current in the horizontal semicircular canal results in an irritation almost twice as strong as an ampullofugal current. A detailed analysis of the change of the nystagmus during the time following the operation forces the author to the belief, however, that this asymmetry of the rotation nystagmus, which in reality is only an apparent one, is traceable to modifications of the central nervous processes due to the unilateral exclusion of the labyrinth. One could conceive a sort of opening for the nystagmus toward the healthy side. Accordingly, in the rabbit, the irritative effects of ampullopedal and ampullofugal currents would be of approximately equal strength under normal conditions.

The site of elicitation for the nystagmus must be looked for in the cristae of the semicircular canals. It has not been incontestably demonstrated that otoliths also evoke nystagmus, as has frequently been asserted. Lorente de Nó then describes detailed investigations on nystagmus in centric rotations by means of registration of the function of the isolated ocular muscles.

A simple relation between the strength of the current in the semicircular canals and the strength of the nystagmus in centric rotations could not be recognized.

Mathematical calculations revealed that the currents of the endolymph in the different semicircular canals proceed as though the different canals are ducts which are physically completely separated from each other. For the cooperation of the semicircular canals, only the nervous central organs are responsible, where the excitations which arise from the different semicircular canals interlock.

Every semicircular canal may produce nystagmus in all ocular muscles. The characteristics of this nystagmus are, however, essentially dependent on the position of the head in the space in which the stimulation of the semicircular canal takes place.

The irritative effect of the different semicircular canals is not the same. Irritation of the vertical semicircular canals evokes weaker nystagmus than irritation of the horizontal semicircular canals. This may be connected with the fact that during the physiologic movements of the animal the horizontal semicircular canals are chiefly involved. The task devolves on the vertical semicircular canals, especially that of inhibiting the movements of the head when, for instance, it is returned

to the normal position. The otolithic organs will hardly enter into consideration here, because they react too slowly.

In eccentric rotations the nystagmus is very much dependent on the distance and the deviation of the head from the axis of vertical rotation. The laws which apply here are expounded in detail. The rotations do not undergo any change following unilateral extirpation of the labyrinth. Under certain conditions laws other than those for perrotatory nystagmus appear to apply for postrotatory nystagmus. The perrotatory nystagmus is strongest during those rotations which in the normal animal occur under physiologic conditions. Apparently stimulations of the labyrinth due to progressive acceleration at the beginning of the eccentric rotations and to the centrifugal power during the entire rotation are responsible for the changes of the nystagmus in rotations with the head in different positions relative to the axis of vertical rotation. A decrease of the currents in eccentric rotations, so far as this is present, can hardly serve for the purpose of interpretation. It is much too small to explain the great differences in the reflexes.

The reflexes to the centrifugal power, such as they occur in eccentric rotations, manifest themselves in a manner similar to the toxic reflexes on the eyes during a certain inclination of the head of the animal. Quantitative and qualitative differences, however, exist because the mass acceleration which develops during eccentric rotations from the centrifugal acceleration and the weight acceleration possesses a greater absolute value than the weight acceleration alone.

Lorente de Nó next discusses a reflex which has been unknown so far, the so-called third rotation reaction. Muscular spasms which manifest themselves only at the beginning and at the end of a rotation are involved. The third rotation reaction possesses certain characteristics in centric as well as in eccentric rotations. At the beginning of eccentric rotations it consists of rapid contractions, usually of all the muscles. The purpose may be regarded to lie in the fact that the rotation point of the eye during the nystagmus retains a fixed position in the orbit. When the eccentric rotation is stopped, the third rotation reaction manifests itself in the form of a reflex with multiple phases. Among other things, there is a protracted increase of the tonus during the nystagmus. The law of reciprocal innervation is thereby followed.

In dealing with the rotation reflexes in rotations around a horizontal axis, Lorente de Nó states that under such conditions the position of the head in space changes continuously. As a result there is a continuously changing positional excitation besides the excitations produced by the rotations in themselves. These processes interlock in the central nervous organs in a characteristic manner. The nystagmus is dependent on the position of the head in space at the beginning of the rotations as well as on the position of the head when the rotation is interrupted.

During rotations around the horizontal axis reflexes which probably are traceable only to the progressive accelerations of constantly changing direction also manifest themselves.

In this work Lorente de Nó also discusses several facts in the case of caloric stimulation of several semicircular canals. There are several similarities with the rotation reflexes. The caloric stimulation of a semicircular canal has varying effects according to the position of the head in space. The differences are thereby also of a qualitative nature. Thus, for instance, a certain current in a semicircular canal may, according to the position of the head in space, produce nystagmus in an opposite direction in the vertical and oblique ocular muscles. On the other hand, with certain positions of the head, currents in the contrary direction may evoke nystagmus in the same direction. An endolymph current which was calorically evoked may even produce nystagmus with a certain position of the head, but may evoke a reflex in another position which is similar to the third rotation reaction. Isolated irritations of isolated semicircular canals demonstrate that under otherwise equal conditions irritation of a horizontal semicircular canal produces stronger reflexes than irritation of a vertical canal. Here also, all semicircular canals are capable of producing nystagmus in all muscles.

The second part of this work deals with the anatomy of the vestibular nerve. Lorente de Nó deals first with the anatomic conditions of the peripheral terminations. Each terminal site of the labyrinth not only has its own kind of innervation, but also presents special regional differences. The maculae as well as the cristae represent complicated innervation formations. The regional innervation differences involve the caliber of the nerve fibers as well as the special nature of their ramification. The thickness of the otolithic membrane of the macula utriculi shows regional differences with otoliths of various sizes. These peculiarities show an interesting consonance with the regional differences of the innervation.

The terminal sites of the labyrinth project into separated portions of Scarpa's ganglion.

Investigations regarding the development of the nerve terminals furnish sufficient explanation regarding several anatomic facts; for instance, why the macula sacculi is innervated by two nerves in spite of its uniform structure. Studies on embryos also reveal that the macula utriculi actually develops from two originally separate anlages, and that the crista which is a uniform formation at the beginning splits in two halves in the course of development, each of which is supplied by a special nerve.

It was positively established that the vestibular nuclei in the rhomboid fossa do not alone determine the development of the reflexes.

The nuclei of the formatio reticularis also cooperate. An interlocking of the excitations from the different terminal sites of the labyrinth takes place within the nuclei at the floor of the fourth ventricle. The nucleus triangularis plays a principal rôle in this process.

The labyrinthine reflexes on the ocular muscles develop even when the posterior longitudinal bundle and all the other longitudinal tracts which connect the nuclei of the vestibularis with the nuclei of the ocular muscles are severed. This therefore signifies that the short tracts of the formatio reticularis which are interrupted several times are sufficient for this purpose.

The conclusion is reached from several experiments that the centers of the substantia reticularis always play a rôle in determining the characteristics of the reflexes. The appearance of spontaneous nystagmus following unilateral extirpation of the labyrinth and the development of the rapid phase of the nystagmus in general are always dependent on the intactness of the substantia reticularis.

LABYRINTHINE PHYSIOLOGY

Le Heux and de Kleyn,[19] after corroborating the finding of Kremer, Spiegel and Demetriodes that there is an increase in the contractions of the stomach and the loops of the small intestine after caloric stimulation of the labyrinth, performed unilateral extirpation of the labyrinth and after a twenty-four hour fast fed their animals and examined them by the x-rays. In these animals they noted that after fifteen or twenty minutes all the food was still in the relaxed fundus, and only a very thin shadow was observed in the pyloric vestibule, while there was no food passing into the small intestine. On subsequent examinations, the movements of the small intestines were also found to be much more sluggish, although not so sluggish as was noted in the stomach. In the large intestine the movement was most sluggish. Vomiting was a very infrequent occurrence. In ten or twelve days the effect of the extirpation wore off, and once again the alimentary function was normal.

The authors concluded that loss of function of the labyrinth was responsible for disturbances of motility.

Lorente de Nó,[18] after performing unilateral extirpation of the labyrinth, noted that the tonic labyrinthine reflexes on the ocular muscles change not only quantitatively, but also qualitatively. It is therefore not possible to regard the tonic reflexes as merely decreased by half after such an operative intervention. It must be especially considered that

19. Le Heux, J., and deKleyn, A.: Acta oto-laryng. **17**:158, 1932.

following unilateral extirpation of the labyrinth, the different muscles show their relaxation or contraction maximum in different positions of the head in space than in the healthy animal.

In normal animals, a characteristic so-called positional nystagmus of the eyes occurs when the head is in positions which under physiologic conditions are used rarely or not at all. Such a nystagmus may be observed when the head approaches the dorsal position.

The discussion of the objective facts and demonstrations from the literature reveal that in the evocation of the tonic reflex the otolithic organs participate first, but that the semicircular canals also participate.

Lund [20] discusses the theories that have been advanced by other writers in explanation of the labyrinthine fistula symptom. He then presented his own theory, which is a development of Mygind's conception of the fistula symptom as an otolithic reaction to an adequate irritation. The author thinks that pressure nystagmus may be ascribed in part to displacement of the crista ampullaris, as pressure causes an endolymph movement which displaces the crista, but the reaction is also due to the general pressure effect on the static sensory epithelium of the labyrinth. In cases of fistula of the semicircular canal, the reversed fistula symptom produced by direct or indirect pressure on the fistula may be ascribed to the effect of pressure on the sensory epithelium of the vestibule and the semicircular canal, whereas the reversed fistula symptom produced by direct pressure in the region of the fenestra may be ascribed to displacement of the endolymph in the semicircular canal. The regular fistula symptom, whether produced directly or indirectly, may be ascribed to the effect produced on the crista ampullaris by the movement of the endolymph toward the ampulla. The effect on the crista supersedes the general pressure effect on the sensory epithelium and therefore determines the direction of the nystagmus. In cases of fistula of the region of the fenestra, the reversed fistula symptom is always purely a pressure symptom, while the direction of the regular fistula symptom may be determined by the movement of the endolymph toward the ampulla over the crista ampullaris. No matter where the fistula is located, the general pressure effect helps to determine the nystagmus, which may therefore be considered as consisting of all three components, the horizontal, rotatory and vertical. When the pressure effect supersedes the endolymph movement effect, the nystagmus is determined by the functioning capacity of the sensory epithelium. The statement of the theory is followed by a long discussion in which Lund shows how the clinical and experimental observations recorded in the literature, as well as his own clinical observations, are explained by his theory.

20. Lund, R.: Theory of Labyrinth Fistula Symptoms, Monatschr. f. Ohrenh. **65**:1511 (Dec.) 1931; abstr., Arch. Otolaryng. **15**:785 (May) 1932.

By means of the evaluation of nystagmus, Woletz [21] made a quantitative study of possible after-effects of vestibular stimuli on the central nervous system. With the help of a series of physically identical irrigations of small volume, a standard value for the rapidity and duration of the nystagmus for each subject was determined; it represented the reaction of that subject to a stimulus of known quantity and quality. The effects of a test irrigation at varying intervals after a disturbance irrigation were noted. At first the disturbance and the test stimulus were tried on the same ear, and in a later series each was tried on a different ear. In all tests a deviation from the predetermined normal reaction was revealed. As a peripheral after-effect of long duration is impossible, the only explanation for these results is a change in the condition of the nerve centers. Clinically, this shows the importance of longer intervals between vestibular examinations to avoid reciprocal influences.

Fischer and Oldberg's [22] investigations of vestibular reflexes show that these are dependent on the condition of the nerve centers. Through simultaneous aqueous irrigation of both ears, under certain conditions, pulsion reflexes are evoked, the duration of which can be exactly determined and proves to be constant under parallel test conditions. When such double irrigations are repeated in a continuous series with ten minute intervals, the pulsion reflexes undergo peculiar changes in the course of the test series. They become shortened and weakened or lengthened and strengthened; sometimes no reflex occurs. The kind of modification depends on the irrigation constants and the irrigation intervals; often in a long test series lengthening and shortening alternate rhythmically. To explain these changing effects trial tests were undertaken by the authors. A so-called disturbance irrigation was employed to produce pulsion reflexes. Then a certain test irrigation (the exact response to which had been determined in previous experiments) was given ten minutes following the disturbance irrigation, and the pulsion reflexes were observed. This combination of disturbance irrigation and test irrigation was tried at other sittings, with intervals of twenty and thirty minutes and longer. In these experiments a modification of the test reflexes was seen, depending on the time relation of the test irrigation to the disturbance irrigation. This can be represented graphically in a curve and exhibits a rhythmic pendulating decrease. Experiments were performed to prove that these peculiarities were not

21. Woletz, F.: Study of Decrease in Vestibular Excitability by Caloric Nystagmus, Ztschr. f. Hals-, Nasen- u. Ohrenh. **30**:524 (May 13) 1932; abstr., Arch. Otolaryng. **16**:425 (Sept.) 1932.

22. Fischer, M. H., and Oldberg, E.: Caloric Vestibular Reflexes and Nervous Centers, Ztschr. f. Hals-, Nasen- u. Ohrenh. **30**:499 (May 13) 1932; abstr., Arch. Otolaryng. **16**:424 (Sept.) 1932.

dependent on changes in the condition of the receptive organ or on vascular reactions. The changes in the test reflexes are provoked solely by disturbance reflexes. They are based on changes of long duration in the excitability of the nervous reflex centers which are caused by the disturbance reflexes. This shows that vestibular reflexes have long-lasting after-effects on the nervous system. Clinically, this means that in functional examinations vestibular stimuli may be employed only with long time intervals if one wishes to avoid gross deceptions.

Cantele and Grahe,[23] in an attempt to ascertain the influence of the cervical sympathetics on vestibular excitability, observed that the nystagmic jerks were definitely fewer on the side on which the sympathetic fibers had been cut. The absolute duration of the nystagmus was also diminished. This disproves the theory of some otologists, who explain the stimulation of the labyrinth as an action through the sympathetic vasomotor system. Others conclude that caloric stimulation is best explained as a direct action on the labyrinthine fluids, and that sympathetic influence is an accessory factor.

In studying the relationship between cerebrospinal and intralabyrinthine pressure, Hughson,[24] after first corroborating the facts that pressure against the round window increases the transmission for high sounds and that reduction of the pressure produces a decreased functional result, performed thirty experiments. Repeated trials showed beyond all question that no instrument could be introduced through the membrana secondaria and fixed firmly enough to permit of accurate pressure readings without seriously damaging the intracochlear structures. He therefore injected hypertonic and hypotonic solutions of sodium chloride intravenously. In each instance in which a hypertonic solution of sodium chloride (30 per cent) was used, a similar reaction was obtained, as though the round window had been opened and the labyrinthine fluid permitted to escape. In two experiments with the hypotonic solution no demonstrable result was obtainable.

Examination of the round windows revealed definite bulging, indicating an increase in intralabyrinthine pressure.

Hughson showed definitely that with an increase in the cerebrospinal fluid pressure there was a constant increase in the intralabyrinthine pressure. There was, however, a certain lag between the rapidity of change; thus, when the cerebrospinal fluid pressure had reached its height and had begun to recede, the intralabyrinthine pressure continued to rise. This resulted because the aqueductus cochlearis is a

23. Cantele, P. G., and Grahe, K.: Influence of Sympathetic Nervous System on Vestibular Excitability, Arch. f. Ohren-, Nasen- u. Kehlkopfh. **130**:281 (Feb. 25) 1932; abstr., Arch. Otolaryng. **16**:749 (Nov.) 1932.

24. Hughson, W.: Am. J. Physiol. **101**:396 (July) 1932.

minute structure, and interchange of fluid takes place very slowly. This had no effect on transmission of tones through the ear. These experiments proved conclusively the intimate relationship between the cerebrospinal fluid pressure and the intralabyrinthine pressure. The accuracy of this method is accomplished by simultaneous use of the Wever and Bray phenomenon.

Huizinga,[25] continuing his study of labyrinthine physiology and working on pigeons, noted after operations on the upper portion of the labyrinth in various animals that the knowledge concerning the function of this apparatus was not enriched. This he attributed to the fact that in such procedures adjacent anatomic portions are inevitably injured. Anatomically, however, he showed that the ampulla of the posterior vertical canal occupies a more isolated position than the ampullae of both anterior arches. While the anterior vertical and horizontal canals communicate with the recessus utriculi, close to the macula utriculi, the posterior ampulla communicates with the narrow posterior sinus, which is a prolongation of the utriculus directed downward and backward. The posterior crista was surrounded by the ampulla more than the horizontal crista, which is located at the level of the recessus utriculi. He succeeded in removing the posterior ampulla in one stage in five pigeons, and in two stages in ten pigeons. The removal of one ampulla produced no demonstrable change in flying. A successive removal of the second posterior ampulla was followed by slow disturbances of short duration. The pigeons intermitted their flight; they became immobile and remained so for a few seconds. When both ampullae were removed in one stage, pendulum-like movements of the pigeon's head or an inclination to turn backward was noted. After a few weeks normalcy set in. When the symptoms were more pronounced, Huizinga proved them to be due to elimination of the function of the entire labyrinth by the use of rotation tests. Histologically, he noted that the posterior ampullae were completely removed and replaced by loose connective tissue. The posterior sinus was closed. He concluded, therefore, that undoubtedly both anterior cristae and the macula utriculi are the most important parts of the organ of equilibrium. However, it would be incorrect to assume that the sensory epithelium of the lower portion of the posterior ampulla is of no great physiologic importance. The remaining sensory epithelium takes over the function of the removed portions. Such a phenomenon may be called peripheral compensation in contradistinction to a central compensation which always takes place in such cases.

25. Huizinga, E.: Arch. f. d. ges. Physiol. **229**:441, 1932.

Thornval,[26] in an attempt to find a more practical method for the study of the quantitative caloric test, considers that it is necessary to make the cold caloric test on one ear and the hot test on the other ear. The temperature of the water, which was 7 degrees above or 7 degrees below body temperature, was determined accurately, and the injection was discontinued when the reaction appeared. The duration of the nystagmus was then measured.

It was found that the shortest reaction time in normal persons after stimulation with cold water was ten seconds, and the longest, thirty-one seconds. With hot water, the corresponding figures were twelve and thirty seconds. In the ventral position, the shortest reaction time after stimulation with cold water was twenty-four seconds, and with hot water, seventeen seconds; the longest reaction time after stimulation with cold water was thirty-two seconds, and with hot water, thirty-seven seconds. In the same person, the greatest difference in the time of reaction after stimulation with cold water was eleven seconds, and with hot water, twelve seconds. With the same person in the dorsal position, the greatest difference in reaction time between the tests with hot and with cold water on the same ear was sixteen seconds. The average reaction time of the cold caloric tests made on the right ear of persons in the dorsal position was eighteen seconds, while it was twenty seconds on the left ear. The corresponding figures for the test with hot water in the dorsal position were nineteen and twenty seconds. In the ventral position, the corresponding figures for the test with cold water were twenty-nine and twenty-seven seconds, and for the test with hot water, twenty-three and twenty-eight seconds.

By using the foregoing figures in making a critical evaluation of the findings in pathologic cases, this method can serve for a quantitative determination of the function of the vestibular apparatus.

Thornval,[27] in another group of experiments dealing with the movements of the endolymph in the labyrinths of pigeons, concludes that by the production of such movements in the nonampullar end of the occluded semicircular canal reflex movements may be produced in the vertical semicircular canals, which are most constant when the pressure is increased, and also in the horizontal semicircular canals, in which the movements are most pronounced when the pressure is decreased (suction). These reflex movements cannot be explained by the influence on the ampulla, and the question arises whether one has to deal with reflexes from the utricle. Assuming that the reflexes originate from the utricle, an attempt must be made to explain why in the vertical semicircular canals the movements are produced under the influence of

26. Thornval, A.: Acta oto-laryng. **17**:163, 1932.
27. Thornval, A.: Acta oto-laryng. **16**:384, 1932.

an increased pressure, while in the horizontal semicircular canals they are produced under the influence of a decreased pressure. It is possible that there is a difference in the anatomic structure of the vertical and the horizontal semicircular canals. Definite and absolute conclusions cannot be drawn at present, and the subject must further be studied.

Steinhausen,[28] in a preliminary report on the spontaneous movement of the cupula in the ampullae of the semicircular canals, has perfected a technic whereby he is able to observe the movements of the cupula during the disturbances in the endolymphatic fluid.

Utilizing caloric and rotatory stimuli, he finds that the deviation of the cupula is in the direction of the flow of the endolymphatic fluid. This deviation returns to normal on cessation of the induced current flow. These observations confirm Mach-Breuer-Brown's original contention, namely, a mechanical theory of irritation of the semicircular canals.

Spontaneous movements of the cupula can be studied only if a deviation of the cupula is produced without movements of the endolymph. Steinhausen accomplished this by prolonged rotation.

This experiment is analogous to the rotatory experiment in man and is used for the production of rotatory nystagmus. Steinhausen found that the duration of the nystagmus corresponds to the duration of the vibrations of the cupula. His experiments confirmed, therefore, the relations of deviations of the cupula to the rotatory nystagmus.

Wittmaack [29] presents a critical discussion of Steinhausen's experiment in visual observation of the deflection of the cupula. In this experiment, performed on pikes, the skull was opened, the brain removed and the anterior vertical ampulla exposed. After fixation of its wall, a small hole was made in the wall of the semicircular canal, a little india ink injected and the hole plugged. The outlines of the cupula were then seen as black contours in the instrument used for observation, and deflections of the cupula due to movements of the endolymph were observed. Steinhausen claims that this experiment not only substantiates the Mack-Breuer theory of deflection, but also effectively disposes of all other theories of stimulation of the cupula. Wittmaack thinks that Steinhausen's experiment can in no way be considered to dispose of his own conception of stimulation of the cupula, which is built on his theory of tonus, because turgescence of the cupula, which is the basis of the theory of tonus, was destroyed in this experiment by exclusion of the circulation and the lymph fluid pressure. He considers

28. Steinhausen, W.: Arch. f. d. ges. Physiol. **229**:439, 1932.

29. Wittmaack, K.: Observations on Steinhausen's Experiment, Arch. f. Ohren-, Nasen- u. Kehlkopfh. **130**:254 (Jan. 21) 1932; abstr., Arch. Otolaryng. **16**:118 (July) 1932.

it erroneous of Steinhausen to deny the quality of turgor in the vitally functioning cupula and to dispute the theories based on the assumption of turgor merely because the cupula examined by him after exclusion of all fluid circulation was found flaccid. Wittmaack sees no value in demonstrating that the cupula in a dead animal can be deflected by movement of the endolymph. The question to be answered is whether the cupula in the living animal under normal conditions of circulation and lymph fluid pressure is a flaccid, unresistant structure as in death or whether in the living animal it becomes stiffened because of its own turgor and is therefore able to offer resistance to the endolymph flow of the semicircular canal, so that this flow would influence the cupula not only through deflection but also through a change in the hydrostatic pressure in the cupula. As this question cannot be answered by experiments on a dead animal, and as direct observation of a living one is impossible, indirect methods must be used. Wittmaack thinks that the best way to determine whether the specific excitation of the sensory organs produced by caloric or rotatory stimuli is the result of deflection of the cupula or of a change in the hydrostatic pressure of the cupula, both being produced by movement of the endolymph, is by allowing these factors to be exerted separately. While he has found no way of causing a deflection in the cupula without simultaneously exerting pressure on it, he describes an experiment in which the influence of pressure alone was allowed to act by means of a fine cannula inserted into a small hole in the lowest spiral of the scala tympani; this pressure was transmitted to the endolymph according to laws of hydrostatic pressure and from it to the cupula. Pressure resulted in typical nystagmus toward the stimulated side, and suction produced nystagmus to the opposite side. The nystagmus followed the same rules of direction as caloric nystagmus. As deflection of the cupula was not possible in this experiment, it must have been the change in the pressure that resulted in the identical reactions produced by rotatory and caloric stimuli.

OTOLITHIC APPARATUS

In a comprehensive comparative study of the function of the saccular macula in mammals, Tait [30] offers the following opinion:

> We must remember that the cochlea and its accessory apparatus (membrana tympani, ossicles, etc.) are designed to vibrate in an immobile head; further, that the mere construction of the saccular receptor suggests that stimulation involves an actual vibration or tremor of the head. We have no evidence that in any terrestrial vertebrate the saccular macula is commonly stimulated by tremor communicated to the body itself from the outside—that is to say, we have no evidence that the saccular macula of land vertebrates is a simple exteroceptor.

30. Tait, J.: Ann. Otol., Rhin. & Laryng. **41**:681 (Sept.) 1932.

When we consider that all production of voice by air breathing vertebrates is liable to cause head tremor, it is perhaps a fair inference that the saccular macula in these animals is a properioceptor involved in the emission and regulation of voice.

This would mean that we hear our own voice with the help of two kinds of receptor, while we hear the voice of our neighbors with only one. If this were so, it would be easy to understand why we fail to recognize a phonograph record of our own voice as easily as it is recognized by our friends. The suggestion here advanced is, of course, open to investigation by the recognized method of comparing careful clinical records with subsequent postmortem findings. Occasional cases may arise in which the saccular apparatus may be thrown out of commission without involving the cochlea. A more common type of case is probably one in which cochlea disability is grave while the saccular maculae remain unaffected. Only when a number of properly selected patients have been thoroughly examined and interrogated from this point of view and the findings subsequently checked by anatomic examination, shall we be able to say whether the hearing of our own spoken voice involves the mediation of two separate labyrinthine receptors, cochlea and saccular macula.

Hasegawa,[31] utilizing the method employed by Magnus in a study of otolithic physiology, centrifugated guinea-pigs and noted the change in the labyrinthine reflexes so produced. Although his results differed somewhat from those obtained by Magnus, he came to the following conclusions:

1. The static reflexes may partly be produced without the otolithic membranes.

2. The reactions to straight movements can no longer be produced in the absence of the otolithic membranes.

3. The reaction obtained to straight movements in the normal position of the animal, in the direction of the dorsoventral axis, is conditioned by both saccules, and that produced in the direction of the longitudinal axis of the body is conditioned by both utricles.

4. The spontaneous nystagmus in a certain position of the head following centrifugation occurs as a result of traction of a separated otolithic membrane on the cupula.

5. Following centrifugation, regeneration cannot be demonstrated in these animals physiologically or anatomically.

VASOMOTOR APPARATUS

Bettin,[32] studying the vasomotor reactions and the vestibular apparatus, points out that numerous writers, especially Portmann, maintain that the nystagmus is based on vasomotor effects. This view is opposed to Bárány's theory; he refers caloric nystagmus to the change in the

31. Hasegawa, T.: Arch. f. d. ges. Physiol. **229**:205, 1931.

32. Bettin, G. G.: Riv. oto-neuro-oftal. **8**:168, 1931.

density of the endolymph in the horizontal semicircular canal brought about by the temperature-conduction capacity of the bone (which is six times greater than the conductivity of the air). As shown by a tabulation, Bettin, by means of the instillation of a 1:1,000 dilution of epinephrine as a sympathicostimulating agent, obtained the same results as with irrigations with cold water; by means of glyceryl trinitrate, the same results were obtained as with irrigations with warm water (sympathetic inhibition). The transmission took place through the superior cervical ganglion. In this work, epinephrine was employed as a stimulating agent and glyceryl trinitrate as an inhibitory agent for the study of the stimulation or inhibition of the sympathetic nerve by certain medicinal substances. Solutions of these substances were introduced by instillation into the auditory meatus; the cold water was subsequently replaced by epinephrine and the warm water by glyceryl trinitrate. Under employment of epinephrine, Bettin observed vasoconstriction of the internal ear besides peripheral vasoconstriction. Some reactions were also obtained which are generally produced by the Bárány "frigid test." These reactions are naturally induced by a vasomotor phenomenon due to the action of the epinephrine. By means of experimentation with glyceryl trinitrate, through vasodilatation of the internal ear, reactions due to the labyrinthine hyperreflectivity were obtained. Bettin points out, however, that an anatomic explanation of these manifestations is impossible on account of the as yet uncertain knowledge of the connections existing between the sympathetic system and the vestibular apparatus. In the light of the most modern conceptions (Petoff, Langly, Spadolini and others), which show that the action of the sympathomimetic and parasympathomimetic substances is exerted locally, it becomes intelligible how the topical application of epinephrine and of glyceryl trinitrate can determine through a territorial action the vasomotor phenomena, representing an adequate and sufficient stimulus for the appearance of the reactions on the ocular muscles and the muscles of the limbs, as well as the collateral or acoustic phenomena (dysacousia) and the balance phenomena (vertigo), noted on physiologic and pathologic stimulation of the internal ear. The endolymphatic currents are more or less decisive in this connection. The pharmacodynamic action of the utilized substance is presumably related to peculiar conditions of the elements on which these substances act (the application of Ehrlich's theory of side chains to the protoplasm), through which one identical substance may eventually determine on the same element an opposite action, according to its encountering the same in one phase or in another phase. In a general way, Bettin's investigations serve to support in some manner the vasomotor theories of nystagmus and of vestibular reactions in general.

Since 1925 Muck [33] has performed the epinephrine probe test on all of his patients afflicted with otosclerosis, and he has found the pathologic vasomotor reflex phenomenon of the white streak in every case. This indicates that the tonus in the region of the internal carotid artery or the auditory artery is disturbed in these cases. The innervation of the auditory artery by fibers of the sympathetic system has been recently demonstrated. As the close relationship between the endocrine system and the vascular system is known, Muck thinks that this gives a key to further study. Recent investigations indicate that there is a disturbance of intermediary metabolism in otosclerosis; some investigators attribute this in part to endocrine causes. Muck was able to demonstrate by means of a change of diet that there are metabolic disturbances in persons afflicted with otosclerosis. A meatless diet was administered for five days to thirty-seven women and girls suffering from otosclerosis; at the end of this period, the white streak sign either disappeared entirely or the duration of contraction of the white streak was decreased to about one half of its length previous to the institution of the meatless diet. On renewed consumption of meat, the white streak sign reappeared. The author thinks that it would be valuable to make a study of the metabolism of patients with otosclerosis before and after the administration of the diet described by him.

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33. Muck, O.: Ztschr. f. Hals-, Nasen- u. Ohrenh. **30**:375, 1932.

News and Comment

SOCIETY NEWS

Academy of Ophthalmology and Otolaryngology.—The Thirty-Eighth Annual Convention of the American Academy of Ophthalmology and Otolaryngology will be held in Boston, Sept. 16 to 22, 1933, at the Hotel Statler. In brief, the program will be as follows:

Saturday, September 16: 8:30 a. m., examination, American Board of Otolaryngology and Massachusetts Eye and Ear Infirmary.

Sunday, September 17: 11:00 a. m., Council meeting. 3:00 p. m., President's reception. 5:30 p. m., public meeting.

Monday, September 18: 8:00 a. m., registration. 9:00 a. m., joint session. 2:00 p. m., Section on Ophthalmology; "Histopathology of the Ear, Nose and Throat;" moving pictures, otolaryngology; demonstration of new instruments, otolaryngology. 5:30 p. m., meeting, Teachers' Section. 7:15 p. m., dinner, Teachers' Section.

Tuesday, September 19: 9:00 a. m., Section on Instruction; "Histopathology of the Eye;" examination, American Board of Ophthalmology and Massachusetts Eye and Ear Infirmary. Afternoon, recreational activities: 1:00 p. m., golf tournament; ladies' party; sight-seeing trips. 8:30 p. m., bridge.

Wednesday, September 20: 9:00 a. m., Section on Instruction; "Histopathology of the Ear, Nose and Throat." 2:00 p. m., Section on Otolaryngology; moving pictures, ophthalmology; "Histopathology of the Eye;" demonstration of new instruments, ophthalmology. 5:00 p. m., Speech Readers' Guild. 7:00 p. m., banquet.

Thursday, September 21: 9:00 a. m., Section on Instruction. 2:00 p. m., "Histopathology of the Ear, Nose and Throat;" Section on Ophthalmology. 5:00 p. m., business meeting. 7:00 p. m., dinner, Transportation Committee.

Friday, September 22: 9:00 a. m., Section on Otolaryngology; "Histopathology of the Eye." 2:00 p. m., Harvard Medical School demonstration.

For full information apply to the Executive Secretary-Treasurer, Dr. W. P. Wherry, 1500 Medical Arts Building, Omaha.

Abstracts from Current Literature

Ear

ACUTE MASTOIDITIS. W. CROSSE, M. J. AUSTRALIA **2**:253 (Aug. 27) 1932.

The symptoms and differential diagnosis of acute mastoiditis are presented, and early operation is advocated. The relationship of the incidence of otitis media to the presence of adenoids is emphasized. Early myringotomy is recommended in all cases of disease of the upper respiratory tract when a sudden rise in temperature and an inflamed or bulging drum, or both, occur. In otorrhea following myringotomy, a gauze wick in the canal down to the drum is recommended in preference to syringing.

GONCE, Madison, Wis. [AM. J. DIS. CHILD.]

ACUTE MASTOIDITIS WITH INCIPIENT THROMBOSIS OF THE LATERAL SINUS. DOUGLAS GUTHRIE, Tr. Edinburgh Med.-Chir. Soc., 1932, p. 169; in Edinburgh, M. J., October, 1932.

This child, aged 7 years, did not have the usual febrile reaction, although there was pus in the ear and the mastoid was tender. When at operation the bone was removed, a large abscess was encountered, and pus spurted out. The lateral sinus was exposed, but found covered with a layer of granulation tissue. The sinus was not opened, but radical mastoidectomy was performed because of destruction of the middle ear and the presence of a cholesteatoma. Such an operation is not often necessary in a child under 12 years.

NEFF, Kansas City, Mo. [AM. J. DIS. CHILD.]

FURUNCLE OF THE EAR CLOSELY SIMULATING MASTOIDITIS. DOUGLAS GUTHRIE, Tr. Edinburgh Med.-Chir. Soc., 1932, p. 170; in Edinburgh M. J., October, 1932.

The clinical condition in the child presented simulated acute mastoiditis, and the ear was discharging and tender. But the groove which remains apparent behind the ear in mastoiditis was obliterated in the furuncle by the swelling; movement of the jaw or ear caused pain, and with the aid of a small speculum the normal membrane could be seen beyond the furuncle.

NEFF, Kansas City, Mo. [AM. J. DIS. CHILD.]

SEQUESTRATION IN THE PETROUS PORTION OF THE TEMPORAL BONE: DIAGNOSTIC SIGNIFICANCE OF ROENTGENOTHERAPY. AMERSBACH, Arch. f. Ohren-, Nasen- u. Kehlkopfh. **133**:253 (Dec. 19) 1932.

Amersbach says that while pathologic changes in the soft parts of the labyrinth cannot be diagnosed in the roentgenogram, destruction and sequestration of the labyrinthine capsule can be clearly recognized (particularly with Stenvers' method) in the majority of cases. In at least a part of the cases in which the process of sequestration surrounds the entire labyrinthine section, the process follows the preformed path of the perilabyrinthine mastoid cells. In such cases the sequestration usually cannot be recognized unless a comparison with a roentgenogram of the healthy side is made. The author considers this indispensable. Such a comparison usually permits the distinction of fine differences between the structure

and boundary of the cells of the perilabyrinthine system, on the one hand, and the destruction in the region of the granulating sequestration on the other hand. The author reports two cases of sequestration of the labyrinth. Under favorable circumstances the function of the facial nerve may be preserved in total sequestration of the labyrinth, and with the correct technic its function may also be preserved in the removal of large labyrinthine sequestrums. EDITOR'S ABSTRACT.

PARALYSIS OF FACIAL NERVE IN UFFENORDE'S LABYRINTHINE TEST. H. LOEBELL, Arch. f. Ohren-, Nasen- u. Kehlkopfh. **133**:288 (Dec. 19) 1932.

Loebell reports the accidental occurrence of paralysis of the facial nerve following Uffenorde's labyrinthine test. This test, which is recommended in cases requiring total opening of the cavity of the middle ear, consists in placing a cotton pledget saturated with ether first behind and then in front of the promontory over the lateral semicircular canal and observing the nystagmus. In the case reported, a few moments after the test, which gave a normal caloric reaction, paralysis of the facial nerve was observed. The paralysis receded within about three hours. The author thinks that the paralysis was due to the cooling of the nerve by ether dropping from the saturated pledget. Such an intensive cooling effect on the nerve is possible not only in cases of cholesteatoma with erosion of the facial canal but in cases of dehiscences near the oval fenestra, which exist in from 50 to 60 per cent of all persons. In the author's knowledge this case is unique. To avoid such accidents the excess ether should be squeezed out of the cotton and the pledget should be applied lightly. EDITOR'S ABSTRACT.

TREATMENT OF TUBERCULOUS MASTOIDITIS IN CHILDREN. H. ROLLIN, Arch. f. Ohren-, Nasen- u. Kehlkopfh. **133**:293 (Dec. 19) 1932.

In two cases of tuberculous mastoiditis in children, Rollin successfully employed roentgen irradiation in place of surgical intervention. The tuberculosis in both cases was limited to the middle ear, and the mastoid cells and other organs were not affected. There were no signs of foci of disintegration caused by a mixed infection. In each case three treatments resulted in the disappearance of the granulations in the auditory meatus as well as of the mastoid swelling. The secretion stopped, and the tympanic membranes closed by cicatrization. The decreased hearing capacity returned almost to normal. There have been no recurrences in two years of observation, and no decrease in the hearing capacity has been observed as a result of the roentgen irradiation. The author recommends roentgen therapy as the method of choice in positively diagnosed tuberculous mastoiditis in children when it is not complicated by foci of disintegration due to a mixed infection. EDITOR'S ABSTRACT.

TREATMENT OF MASTOIDITIS. HERMANN ZISCHINSKY, Jahrb. f. Kinderh. **136**:310 (Sept.) 1932.

Forceful presentation of the argument for conservative treatment of mastoiditis is given; it is based on the observation of 181 cases occurring among 76,000 cases of infectious disease at Popischill's clinic. At the first local sign of mastoiditis, a leech is applied, and often cure is obtained. If not, heat is used until a subperiosteal abscess fully matures. Under local anesthesia, this abscess is incised and drained. Antrotomy is never done unless cerebral complications or sinus thrombosis develops, or unless the conservative method fails. The ultimate results appear to be good.

CLAUSEN, Rochester, N. Y. [AM. J. DIS. CHILD.]

HISTOPATHOLOGIC CHANGES IN EARS OF WHITE MICE RESULTING FROM NOISE AND VIBRATION IN METAL FACTORY. N. F. POPOFF, Monatschr. f. Ohrenh. **66**:1488 (Dec.) 1932.

Popoff exposed white mice for eight hours daily to the noise of a metal factory (hammers beating 200 times per minute). After twenty days, destruction of Corti's organ in the basal spiral of the cochlea and pathologic changes of the ganglionic cells of this spiral were seen. After three months, destructive changes in the upper spirals of the cochlea were also seen, as well as beginning disintegration of the ganglionic cells and of the afferent and efferent nerve fibers. After from eight to nine months these changes were intensified; in the upper spiral all ganglionic and nerve cells were completely destroyed; Corti's organ was temporarily preserved in these spirals, but it also was destroyed later. In the vestibular apparatus, signs of irritation and degenerative atrophic changes were seen. The analysis of the noises showed that the intensity of the low tones was more than twice that of the high tones; the vertical vibrations of the floor had a frequency of 31 per second, which produced low tones and hence increased the noise. The summation of the energy of the low tones and the vibration probably caused the destruction of Corti's organ, with its nerves, in the upper spirals of the cochlea. The primary degenerative atrophy of the spiral ganglion and its nerves and the secondary destruction of Corti's organ in the upper spiral of the cochlea may depend largely on the vibrations, as Wittmaack has shown. The intensity of the changes produced in the ear was variable. The pathologic changes in the ear are not caused only by the influence of external factors, but depend also on the condition of the neuroglandular apparatus, the physicochemical condition of the tissue and the genetic and phenotypic characteristics of the organism.

EDITOR'S ABSTRACT.

METASTATIC CEREBRAL ABSCESSES IN OTOGENOUS PYEMIA IN A CHILD AGED NINE YEARS. I. HOFER, Ztschr. f. Hals-, Nasen- u. Ohrenh. **32**:221 (Nov. 12) 1932.

Hofer reports the case of a child, aged 9 years, with an otogenous pyemia, sinus thrombosis, bulbus thrombosis, a peribulbar abscess and jugular thrombosis, with complete suppuration of the thrombi in the jugular vein; the source of the infection was an old putrefied cholesteatoma. Simultaneously there was a labyrinthine fistula in the horizontal semicircular canal, with injury to the labyrinth but without total loss of labyrinthine function. Cerebral complications which set in about two weeks after an apparently successful intervention on the sinus and bulbus ended in death a few weeks later. At necropsy a large bifurcated abscess was found in the right frontal lobe and another one in the right occipital lobe, which had perforated into the posterior horn of the lateral ventricle. The age of the abscesses could not be determined. The large ones had a pyogenic membrane; the small one did not. The author thinks that the abscesses were metastatic, as no direct route for the spread of the infection could be found. The dura of the posterior and median cranial fossa appeared normal. The abscesses of the brain had probably existed for months in latent form, and suddenly became manifest at a time when the sinus and bulbus thrombosis were in the process of healing. Two days before death 5 cc. of pus was aspirated from the posterior horn of the right lateral ventricle, but the abscess itself could not be reached. No metastases were found in any of the other organs.

EDITOR'S ABSTRACT.

Pharynx

A NOTE ON SCARLET FEVER FOLLOWING OPERATIONS IN THE NASOPHARYNX. ALEXANDER JOE, Brit. M. J. **2**:351 (Aug. 20) 1932.

The author draws attention to the frequency of scarlet fever following operations on the nasopharynx, stating that in his opinion and in the opinion of others it follows tonsillectomy more frequently than any other condition.

He suggests for prophylaxis that all children should be given the Dick test beforehand, and that those with positive reactions should be passively immunized before the operation.

ROYSTER, University, Va. [AM. J. DIS. CHILD.]

ELECTROCOAGULATION OF TONSILS: SOME CLINICAL, PATHOLOGIC AND BACTERIOLOGIC OBSERVATIONS. R. GRAHAM BROWN and J. V. DUHIG, M. J. Australia **2**:1 (July 2) 1932.

In seven cases in which electrocoagulation of the tonsils was performed, it was necessary to enucleate the remaining tissue. Electrocoagulation had failed to destroy the tonsils completely; the remaining tissue was not sterile; relief from clinical symptoms had not been obtained, and the procedure had proved tedious and not without considerable pain.

GONCE, Madison, Wis. [AM. J. DIS. CHILD.]

THE TREATMENT OF ACUTE AND CHRONIC TONSILLITIS. J. F. O'MALLEY, Practitioner **129**:531 (Nov.) 1932.

Under the heading of acute tonsillitis, the author discussed the simple catarrhal form, the acute follicular form and peritonsillitis. The treatment of the first form represents that used for the common cold. For the follicular type, treatment aims to diminish any further toxic invasion of the tonsil and also to stimulate elimination to remove toxins circulating in the blood. The author uses a single application of an 80 per cent solution of silver nitrate to the tonsils to obtain the first objective, and he believes that causing free perspiration is of great value in effecting the elimination of toxins.

The indications for and the technic of surgical treatment for peritonsillitis are also discussed.

The relation of acute tonsillitis to certain complications, i. e., respiratory obstruction, acute rheumatism, otitis media, recurring earaches, deafness and acute mastoid disease, is given careful consideration.

Under the division "chronic tonsillitis," the forms of follicular, hyperplastic and tuberculous tonsillitis are presented.

SAPPINGTON, San Francisco. [AM. J. DIS. CHILD.]

ADENOIDS. F. PIERCE STURM, Practitioner **129**:560 (Nov.) 1932.

In this article, the author deals exclusively with adenoids. He describes carefully their embryologic development and anatomy. In regard to function, the author states that adenoids act as a test organ for respiratory fluids, i. e., the inspired air current and the systemic blood. In this capacity they take samples of all atmospheric micro-organisms and also prepare immunizing substances. Another function attributed to adenoids is the manufacture of hormones in connection with the endocrine system.

In the etiology of hypertrophy, Sturm places heredity as a predominating factor in about 50 per cent of cases. Syphilis, tuberculosis and rickets apparently are not causal factors. Cases are distributed equally among breast-fed and bottle-fed children, and also between the sexes. The author believes that, apart from heredity, the predisposing factors of improper food and foul air are of great importance. In regard to the relative frequency of hypertrophied adenoids and hypertrophied tonsils, in a series of 572 patients operated on by the author, 15 had enlarged tonsils only, 282 had enlarged adenoids only, and in 275 both were hypertrophied. The treatment recommended is surgical removal, and the author, after using the La Force adenotome in more than 3,000 consecutive cases, believes that it is the most efficient instrument available. A detailed description of the technic, including diagrams, is given.

SAPPINGTON, San Francisco. [AM. J. DIS. CHILD.]

THE ADENOID HABITUS AND CALCEMIA. CONCEPTION SESENA DEBEN, Pediat. españ. **21**:137 (March) 1932.

The author concludes that the person with adenoids is definitely susceptible to tuberculosis on account of his lowered resistance. She believes that vitamins as well as the administration of calcium chloride cause only a transitory elevation of calcium in the blood. The calcium in the blood of the person with adenoids is lower than normal. According to her observation, removal of the adenoids will cause elevation of the blood calcium.

SCHLUTZ, Chicago. [AM. J. DIS. CHILD.]

TONSILLECTOMY AND THE SCHICK REACTION. D. OROSZ and G. KUGLER, Arch. f. Kinderh. **94**:168 (Sept. 11) 1931.

Of 161 children on whom the Schick test was performed from one to six years after they had had their tonsils and adenoids removed, 80.7 per cent of those between 2 and 6 years of age, and 68.7 per cent of those between 6 and 12 years of age, responded with a positive reaction. The results were the same in children in whom hyperplasia of lymphoid tissue had occurred following tonsillectomy and adenoidectomy. The authors found no relation between tonsillectomy and the Schick reaction, and hence were unable to confirm the observations of Schick and Topper published in November, 1929.

LEMASTER, Evanston, Ill. [AM. J. DIS. CHILD.]

A POLYP OF THE EDGE OF THE CHOANAE IN A SMALL CHILD. KARL RUPILIUS, Arch. f. Kinderh. **94**:209 (Sept. 11) 1931.

A 3 year old boy was brought to the clinic because of moderate difficulty in respiration. Breathing was easier when the mouth was held open. Examination showed a bluish-red pedunculated tumor the size of a chestnut hanging from the nasopharynx into the throat. After a few days the tumor suddenly disappeared. Posterior rhinoscopy revealed only a small, fibrin-covered spot on the vomer. Apparently the pedicle broke and the tumor was swallowed. Rupilius suggests that this was probably a polyp of the rim of the choanae which pathologically lay midway between a fibrous and a mucous polyp.

LEMASTER, Evanston, Ill. [AM. J. DIS. CHILD.]

TREATMENT OF DISEASES OF WALDEYER'S RING. CARL AMERSBACH, Kinderärztl. Praxis **3**:289 (July) 1932.

In mechanical obstruction of the nose, adenoidectomy without tonsillectomy is usually sufficient. Except in a few cases of unusual size, hypertrophy of the tonsils is an inadequate indication for tonsillectomy. The author is restricting more and more his indications for tonsillectomy, not because of fear of the operation, but because of disappointment in his results. If operative intervention is indicated, a complete tonsillectomy by the Sluder method, rather than a tonsillotomy, is the method of choice. Electrocoagulation and treatment with roentgen rays and radium are of value only in cases in which even slight bleeding may be dangerous, as in hemophilia.

HUENEKENS, Minneapolis. [AM. J. DIS. CHILD.]

THE ROENTGEN TREATMENT OF TONSILS IN CHILDREN. H. ZOEPFFEL, München. med. Wchnschr. **79**:1753 (Oct. 28) 1932.

Zoepffel reports his results with roentgen treatment of fifty children with hypertrophied tonsils. Good results were obtained in 68 per cent of the thirty-eight children with large, soft tonsils and in 25 per cent of the twelve children with firm, fibrotic tonsils. A result was considered good if the tonsils became smaller and there was an improvement in the subjective symptoms, such an anorexia, impairment of hearing, difficulty in breathing, a tendency toward tonsillitis and

pains in the joints. The treatments were repeated two or three times at intervals of five or six weeks. A few children with fibrotic tonsils were given five exposures. No ill effects were observed. There was no excessive bleeding among those who subsequently required adenoidectomy.

BRAHDY, Mount Vernon, N. Y. [AM. J. DIS. CHILD.]

EXPERIMENTAL HEMATOGENOUS TONSILLITIS. C. KRAUSPE, Virchows Arch. f. path. Anat. **285**:400, 1932.

By the injection of staphylococci and streptococci into the carotid artery of rabbits and cats, an acute, diffuse inflammation of the tonsils was set up. This reaction was often as superficial as that of the spontaneous necrotizing tonsillitis of rabbits, which is due to infection from the surface of the tonsil. When rabbits were sensitized by repeated injections of streptococci subcutaneously, injection of the same strain into the carotid artery caused lesions that were more circumscribed than those caused by the same organism in nonsensitized animals. Such lesions consisted chiefly of histiocytes. Similar small granulomatous lesions were seen also in the tongue, myocardium and kidney. The injection into the carotid artery of bacteria-free, toxin-containing filtrates of streptococci caused inflammatory changes in the tonsils.

SCHULTZ, Evanston, Ill. [ARCH. PATH.]

TONSILLAR CHANGES IN RHEUMATIC FEVER. F. KLINGE, Virchows Arch. f. path. Anat. **286**:333, 1932.

The tissue reactions that Klinge has described as characteristic of rheumatic infection occur in collagenous connective tissue. Such changes are therefore not to be expected in the reticulo-endothelioid lymphoid tissue of the tonsil itself. But in necropsy material rheumatic lesions have been observed in the peritonsillar tissues. Examination of tonsils removed during the acute or subacute stage of rheumatic fever has yielded inconstant results. In two pairs of such tonsils examined by Klinge there were numerous rheumatic lesions of the peritonsillar tissue, and in a third pair there were a few lesions, but in other tonsils the findings were negative. The results of examination of tonsils removed during a first or recurrent attack of rheumatic fever, taken in connection with the results of Sarafoff's examination of tonsils and tissues of the neck at necropsy, warrant the assumption that the rheumatic virus may enter the body through any part of the upper respiratory tract as well as through the tonsils.

SCHULTZ, Evanston, Ill. [ARCH. PATH.]

Larynx

DIATHERMY IN LARYNGEAL DISEASE. L. RECHNITZER, Monatschr. f. Ohrenh. **66**:1473 (Dec.) 1932.

Rechnitzer reports favorable results with diathermy of the larynx in laryngitis, phonasthenia, spastic dysphonia and dysphagia. In all of the ten patients with laryngitis who received treatment with diathermy, rapid disappearance of subjective symptoms and restitution of the disturbed function, often after the first or second treatment, were observed. In contrast with this, the restitution of a normal laryngoscopic picture required from one to four weeks. In twelve cases of phonasthenia due to overexertion, febrile disease, laryngitis and other causes, rapid and permanent improvement was obtained. In four cases of phonasthenia which were caused by poor vocal technic, the improvement was transitory. Favorable results were also obtained in spastic aphonia and in dysphonia. Diathermic treatment of dysphagia resulting from tuberculosis and carcinoma resulted in all but one instance in the alleviation or disappearance of pain for from eight to twenty-four hours in cases in which the usual measures had brought no alleviation.

EDITOR'S ABSTRACT.

LARYNGEAL EDEMA DURING EPIDEMICS OF INFLUENZA. E. ERDÉLYI, Monatschr. f. Ohrenh. **67**:52 (Jan.) 1933.

During the epidemic of influenza in 1930 and 1931, Erdélyi observed eleven cases of laryngeal edema. In most cases the edema occurred in connection with typical influenza; in a few it followed mild tonsillitis. It usually affected the lingual surface of the epiglottis or the region of the arytenoid cartilage; in a few cases the aryepiglottic fold also was involved. The laryngeal disease in all cases was characterized by a short, mild course, terminating within a week without suppuration or other serious complications. The chief symptom was always dysphagia of varying degree, but never real dyspnea. While the literature contains other reports of the frequent occurrence of laryngeal edema in influenza, most of them concern a severe form. The author thinks that the light forms observed by him are due to infection with organisms of low virulence (from the influenza infection), favored by decreased local resistance due to cooling. The author employed expectant, conservative antiphlogistic therapy in most cases. In a few instances in which the edema, especially in the aryepiglottic fold, showed a tendency to spread, scarification with a 20 per cent solution of cocaine and epinephrine was performed under local anesthesia. Edema of the lingual surface of the epiglottis and the region of the arytenoid cartilage stops at the entrance to the larynx and does not spread into the lumen; but edema of the aryepiglottic fold can spread to the interior of the larynx, and it is this form which is most likely to cause dangerous dyspnea, necessitating tracheotomy or ending in asphyxiation. Dysphagia which is not explained by the pharyngeal condition demands a laryngoscopic examination to determine whether there is any inflammation. The slightest sign of laryngeal edema calls for the utmost precaution as the prognosis even when apparently favorable is always uncertain.

EDITOR'S ABSTRACT.

UNILATERAL COMBINED LARYNGEAL PARALYSIS AS THE FIRST SYMPTOM OF CHOLESTEATOMA. H. TAEGEN, Ztschr. f. Laryng., Rhin., Otol. (Teil 1: Folia oto-laryng.) **23**:432 (Dec.) 1932.

Taegen reports the case of a man with Vernet's syndrome the cause of which was not discovered until a diagnosis of cholesteatoma was made twenty-three years after the appearance of the syndrome. Radical operation disclosed that the cholesteatoma occupied the entire mastoid process and had destroyed the major part of the posterior wall of the auditory meatus and the tectorial membranes of the median and posterior cranial fossae. There was a pear-shaped extension at the posterior surface of the pyramid going around the labyrinth and penetrating down into the region of the cerebellopontile angle; the probe also penetrated into the region of the occipital condyle. The pressure of the tumor on the ninth, tenth and eleventh cerebral nerves at the edge of the jugular foramen caused the appearance of Vernet's syndrome, consisting in paralysis of the vocal cords and superior pharyngeal constrictor on the left side, atrophy of the left sternocleidomastoid and trapezius muscles and hypesthesia of the left half of the tongue. The patient had had chronic bilateral otitis media from the third to the eleventh year, but the ears had been dry for twenty years preceding the onset of the syndrome, and no aural symptoms accompanied it. Seven years after the appearance of the syndrome there was a slight discharge from the left ear with perforation of the membrane, but it was of short duration. The author thinks that the tumor was a true cholesteatoma having no connection with the aural disease of childhood. This opinion is supported by the abnormal size of the tumor, the fact that it was nonfetid, dry, waxlike and easily detached from the polished-looking walls of the osseous cavity, and the fact that its earliest symptom, the paralysis of the ninth, tenth and eleventh cerebral nerves, occurred at a great distance from the middle ear. Further, the first otoscopic sign, the appearance

of a small intact white vesicular protuberance in front of the tympanum and the tympanic membrane in the thick osseous auditory meatus a few months before perforation, was characteristic of a true cholesteatoma.

EDITOR'S ABSTRACT.

Nose

A DEFINITE SIGN PATHOGNOMONIC OF PARANASAL SINUSITIS: PRELIMINARY REPORT. MAUD LOEBER, A. J. McCOMISKEY and W. F. HENDERSON, J. Pediat. **1**:565 (Nov.) 1932.

A roughly triangular swelling of the portion of loose skin beneath the outer third of the lower lid over the malar prominence is pathognomonic of a pathologic process in one or more paranasal sinuses of that side. This has been confirmed by rhinologic as well as by roentgenologic examination. Disappearance of the sign is coincident with local improvement of the sinuses involved.

LEMASTER, Evanston, Ill. [AM. J. DIS. CHILD.]

NASAL FACTOR IN GENESIS OF ANAPHYLACTIC BRONCHIAL ASTHMA: CLINICAL OBSERVATIONS AND TREATMENT. E. RUBALTELLI, Arch. ital. di otol. **43**:738 (Dec.) 1932.

Rubaltelli studied a large number of patients with anaphylactic bronchial asthma, and found in a large percentage of them, besides nasal stenosis, a peculiar change in the form and structure of the ethmoid. Considering the nose as an organ of respiration and a reflex center, the author discusses the possibility of the direct and indirect mechanisms through which the nose may occupy first place in the etiology and pathogenesis of anaphylactic bronchial asthma. He concludes that in reality the nose holds an important place in the origin of this allergic disease, either by the changed permeability of its mucosa or by its power of originating reflexes. From the therapeutic point of view, he asserts that prudent and partial operations on special portions of the nasal mucosa ameliorate the course of anaphylactic bronchial asthma because they reduce the zone of possible origin of the reflexes and modify the altered permeability of the mucosa itself.

[ARCH. PATH.]

RETROBULBAR NEURITIS. E. BACHSTEZ, Monatschr. f. Ohrenh. **66**:1349 (Nov.) 1932.

Bachstez states that in eight of fifty-eight patients with retrobulbar neuritis the condition was rhinogenous. Two of them had acute coryza; five showed pus. Among these, three had empyema, one pus on the wall of the pharynx (the findings in the opened ethmoid cell were not recorded) and one pus in the middle nasal meatus. Nothing definite can be said about the sinuses. The patient with pus in the middle nasal meatus was treated only with epinephrine. The eighth patient had a hypertrophied ethmoid mucosa. Of the eight cases, seven exhibited rhinologic symptoms. The eighth was clinically negative but roentgenologically suspicious. This shows that while rhinogenous retrobulbar neuritis is not rare, rhinogenous cases with negative rhinologic findings are rare. Great caution must be exercised in drawing conclusions as to the etiology of the neuritis from the results of endonasal therapy, successful or otherwise. In spite of the rarity of rhinogenous retrobular neuritis without rhinologic symptoms and in spite of the dubious success of endonasal operation, in apparently negative cases in which sweating, injections of milk and epinephrine produce no improvement in from two to three weeks, the rhinologic intervention should be undertaken.

EDITOR'S ABSTRACT.

SEPTICOPYEMIA IN ACUTE SUPPURATION OF FRONTAL AND MAXILLARY SINUS. O. WAGENER, Ztschr. f. Laryng., Rhin., Otol. (Teil 1: Folia oto-laryng.) **23**:219 (Nov.) 1932.

Wagener reports a case of severe septicopyemia occurring in acute suppuration of the frontal and the maxillary sinus. The patient suddenly exhibited signs of prostration accompanied by chills and a strong shift to the left in the blood picture. There had been no local treatment to which this might have been attributed. The jugular vein was ligated, the floor of the frontal sinus and the canine fossa were trephined, and gauze drains were introduced into the openings. The absence of meningeal manifestations or swelling of the eyes indicated that the orbital veins and the sagittal sinus were not involved; this was confirmed by the further course of the disease. The operation brought a decided improvement in the general condition. Metastatic suppurations developed in the foot and thumb in the week following operation, but they healed, and complete recovery occurred. In connection with this case the author suggests that in cases of long drawn out, acute sinus infections in which conservative measures bring no relief, trephination from the exterior may eliminate much suffering. The author has done this in some cases, making only a small opening of about 1 cc. and avoiding the scraping of the mucosa, and has obtained an immediate relief from pain and a quick healing. He has observed no unfavorable results from this procedure.

EDITOR'S ABSTRACT.

LIQUORRHEA NASALIS. K. BECK and H. MARX, Ztschr. f. Laryng., Rhin., Otol. (Teil 1: Folia oto-laryng.) **23**:243 (Nov.) 1932.

Beck and Marx report the case of a woman, aged 39, with a tumor of the hypophysis. Roentgen irradiation brought the process to a standstill, but a fistula developed, probably through the constant pressure of the tumor, and a nasal drip resulted. The amount of spinal fluid which escaped through the nose varied from 800 to 1,500 cc. a day. Roentgen irradiation produced an initial increase in the fluid escape, but half an hour after irradiation there was always a considerable decrease in the secretion, sometimes lasting twenty-four hours. Whether this was due to direct influence on the fluid secretion or changes in the fistular canal cannot be said. The patient's complaint of pressure sensations in the region of the left orbit speaks for the latter explanation. Roentgenization did not achieve a closure of the fistula. Studies of the physiologic exchange between blood and spinal fluid were made.

EDITOR'S ABSTRACT.

PATHOGENESIS OF NASAL TUBERCULOSIS. G. THEISSING, Ztschr. f. Laryng., Rhin., Otol. (Teil 1: Folia oto-laryng.) **23**:379 (Dec.) 1932.

Theissing studied the hematogenous mode of origin of nasal tuberculosis by injecting pure cultures of tubercle bacilli directly into the common carotid artery in guinea-pigs and rabbits. Histologic examination showed that the mucosa and the bone marrow are usually affected simultaneously, or possibly the disease of the bone marrow appears first. The intensity of the changes in the two tissues is variable. The changes in the bone marrow are found chiefly in the lymphoid marrow and less in the fat marrow. In experimental hematogenous infection, the destruction of bone occurs not only through the gradual downward spread from the mucosa, but also from the infectious foci in the marrow. While the sites of predilection for the tuberculous infection in the nasal mucosa cannot be determined in massive experimental infection, the septum was most frequently and most severely involved. In the accessory sinuses hematogenous foci are frequently observed. A comparison of middle ear and nasal changes shows that the latter are generally more extensive.

EDITOR'S ABSTRACT.

Miscellaneous

MEDICAL ASPECTS OF SPEECH DISORDERS. JOHN GLASSBURG, M. J. & Rec. **136**:376 (Nov. 2) 1932.

Disorders of speech are pathologic conditions and require medical treatment. Two types are recognized: stuttering or stammering, and defective phonation. Stuttering is a spastic coordination neurosis based on a mental conflict, and the causes are a predisposing neuropathic constitution, an exciting psychic result and an aggravating pathologic process in the ear, nose, throat or mouth. The treatment is medical, surgical, psychotherapeutic and reeducational. The etiology of defective phonation is central and peripheral. The cerebral causes are mental deficiency, hydrocephalus, amaurotic family idiocy, hereditary ataxia, cerebral hemorrhage, spastic spinal disease, multiple sclerosis, paresis, Bell's palsy, injuries and tumors of the brain, epilepsy, chorea major and eunuchoidism. The peripheral causes are abnormalities of the tongue, throat, mouth, lips, nose and larynx, pressure on the trachea, recurrent laryngeal nerve and vagus and postdiphtheritic paralysis. There are various kinds of aphasia, such as motor, auditory and visual aphasia. Hoarseness, falsetto voice and retarded development of speech are forms of defective phonation requiring medical care.

WILLIAMSON, New Orleans. [AM. J. DIS. CHILD.]

CHANGES IN THE UPPER AIR PASSAGES AND ESOPHAGUS IN RHEUMATIC FEVER. D. SARAFOFF, Virchows Arch. f. path. Anat. **286**:314, 1932.

Gräff and Yoshitake have claimed that in rheumatic fever the infection enters by way of the tonsils and spreads downward through the lymphatics and tissue spaces into the organs of the neck. In seven unselected cases of acute and subacute rheumatic fever Sarafoff made a painstaking histologic study of the tissues of the pharynx, larynx, trachea and esophagus, down to the level of the bifurcation of the trachea. In six of the seven cases there were observed numerous characteristic focal rheumatic lesions, consisting in fibrinoid degeneration of the collagenous ground substance, cellular granulomas and scars. But the distribution of the lesions was not such as to uphold the view of Gräff and Yoshitake, and could be equally well interpreted as the result of widespread localization of the toxic-infectious agent by way of the blood stream.

SCHULTZ, Evanston, Ill. [ARCH. PATH.]

PATHOLOGIC ANATOMY OF BRONCHIAL ASTHMA. W. PAGEL, Virchows Arch. f. path. Anat. **286**:580, 1932.

A man, aged 30, who had been subject to bronchial asthma for years, died suddenly in a paroxysm, evidently as the result of bronchial spasm. The changes that were noted in the bronchi and that Pagel considers characteristic of asthma were the presence of mucous spirals with crystals and eosinophils in the bronchial lumen, eosinophilous infiltration of the epithelium, plateau-like elevations and hernia-like depressions of the epithelium, thickening of the basement membrane, atrophy of the muscularis mucosae and hypertrophy of the smooth muscle of the submucosa. The mucus within the lumen of the bronchus comes in part from the mucous glands of the wall and in part from mucous degeneration of the epithelium. The plateau-like elevation of the epithelium is due to localized thickening of the elastic fibrils of the internal limiting membrane, and this in turn is compensatory to atrophy of the muscle fibers of the muscularis mucosae.

SCHULTZ, Evanston, Ill. [ARCH. PATH.]

Society Transactions

CHICAGO LARYNGOLOGICAL AND OTOLOGICAL SOCIETY

Regular Meeting, March 6, 1933

CHARLES B. YOUNGER, M.D., *President, in the Chair*

RESECTION OF THE SUPERIOR LARYNGEAL NERVE FOR DYSPHAGIA IN TUBERCULOUS LARYNGITIS. DR. IRVING MUSKAT.

The control of dysphagia in tuberculous laryngitis is a most vital consideration to the patient. It allows the patient to obtain sufficient sleep and food necessary to build and conserve the already waning strength of the body. The dysphagia is usually sharp and is unilateral or bilateral or in the middle of the throat. The pain is often referred to the ear on the same side, and increases on swallowing foods, particularly spicy and hot foods. In some cases, citrous fruits or sour food alone causes discomfort. Often there is a burning sensation or a feeling of dryness. Because coughing and swallowing increase the dysphagia, patients refrain from coughing up or swallowing their tuberculous sputum, which collects in an already badly infected larynx, adding insult to injury. The relief from resection or section of the superior laryngeal nerve is definite and lasting. This is in contrast to the control of pain with insufflation of drugs or injection of alcohol. An intraneural injection with alcohol seldom lasts more than thirty days, and most often less, because what is usually accomplished is only a perineural infiltration. Repeated injections of alcohol become more difficult or inefficient because of adhesions from previous injections.

In section of the nerve, infiltration anesthesia with a 1 per cent solution of procaine hydrochloride or a 0.25 per cent solution of butyn is used. The nerve is approached in the following manner: With the patient's head well extended, a horizontal incision is made in the middle of the thyrohyoid space from the middle of the neck to the anterior border of the sternomastoid muscle. The external laryngeal muscles are exposed and retracted medially, and the sternomastoid and large blood vessels are retracted laterally. The nerve is easily found by blunt dissection with a hemostat in its lax tissue bed just as it emerges below and in front of the outer cornu of the hyoid bone. The nerve is severed between two ligatures and the proximal portion buried under the muscles over the larynx. Sectioning the main trunk interrupts the external motor branch to the cricothyroid muscle and pharyngeal plexus as well, but there is no contraindication to this. When the nerve is sectioned, all pain referred through the superior laryngeal nerve is immediately stopped. For about three days following the operation there is some difficulty in swallowing owing to innervation of the external branch to the pharyngeal plexus. When a bilateral section is performed, the motor difficulty is more pronounced and lasts longer, but the patient gets along fairly well on bolus foods.

Several interesting observations have been made on the sensory supply of the larynx with the hot cautery point after section. Although clinically the pain was controlled and dysphagia did not return, in some cases there reappeared several weeks later some pain sense to the hot cautery point, on the side of the section. Other original observations from these studies were that there is an interarborization between the superior laryngeal nerve, the glossopharyngeal and the recurrent pharyngeal, and that the recurrent laryngeal nerve probably

carries sensory as well as motor fibers. Following section of the superior laryngeal nerve, there appears in some cases a recession of the pathologic lesion. There is less secretion, and the mucosa takes on a dusky red hyperemia. That such hyperemia may be due to the unhampered sympathetic fibers is plausible. The disappearance of the pain after resection (section) allows the freeing of secretion by coughing. This minimizes reinfection by infected sputum.

The favorable effect on the general condition following the operation for dysphagia is evident because the patients are again able to take sufficient nourishment and get sufficient rest at night. They gain in weight and in health and take a new lease on life. There is practically no shock to the operation, which is performed in about ten minutes. Sectioning of the superior laryngeal nerve is a boon to these unfortunate persons, and no time should be lost by deferring this most welcome procedure.

DISCUSSION

Dr. Alfred Lewy: I have seen Dr. Muskat perform this operation on a number of patients, and he does it quickly and skilfully. It does not appear to shock the patient much. I have not had an opportunity to follow his patients to the end of their disease, so do not know much of that phase of the subject. However, some patients refuse to have the operation, and some are in such a serious condition that neither this procedure nor any other type of operation is advisable. In such cases I believe the injection of alcohol into the laryngeal nerve has its place, even though a secondary one. I have never seen a case in which this did not help for at least a little while. Some patients receive no benefit after twenty-four hours, but others have from two to six weeks' relief. The injection of alcohol was first employed by Hoffmann, in 1908. Not having seen his article, I conceived the same idea while working in Berlin and tried this experiment on several patients. In one of them a rapid melting down of the tissues occurred, and it was suspected that the bilateral injection had something to do with it, but one could not be sure in a case of that kind.

The most interesting thing about the paper is that Dr. Muskat stated that he does not get complete anesthesia but does get analgesia. Why that is is not known, except that there is still some mystery about the distribution of the nerves to the larynx. Preston, of Iowa City, showed definite communications between the superior and the inferior branches of the nerve, and he was inclined to attribute the loss of function of the abductors, as is commonly seen in the larynx, to the fact that these fibers also carried some motor impulse to the adductors of the larynx but not to the abductors. Be that as it may, Dr. Muskat has not discovered any motor disturbance in the larynx except the loss of function of the cricothyroid, which would naturally follow section of the superior laryngeal nerve instead of the internal branch. He now does not try to find the internal branch, which greatly simplifies the operation.

Dr. Harry L. Pollock: I think some of the results Dr. Muskat obtains, or does not obtain, depend on the marked difference in the course of the nerve. I saw a recent article by I. Belosoy, who suggests a new operation, as it is impossible either by following the superior thyroid artery or by cutting down on the muscle to find all these branches. There are sometimes from ten to twelve branches of this nerve, and one cannot get them all unless they are dissected high. Belosoy advises dissection high in the neck just where the laryngeal nerve comes off the vagus nerve. He says there is not much difficulty. One has to enter the sheath of the large vessels of the neck and find the nerve coming out from under them, and this seems to me a formidable operation, although Belosoy says it is not.

I think the reason there is not complete anesthesia is because of the many branches that come off of the nerve, some high and some low, and unless the dissection is high one could not get all them.

As far as the injection of alcohol is concerned, when I was in Asheville, N. C., Dr. Green showed me several hundred patients. In some of them he produced anesthesia or analgesia for as long as nine months. Unless one makes

the injection directly into the nerve there is only temporary relief, the same as in the gasserian or Meckel's ganglion. If the alcohol is distributed around the nerve, there is only temporary relief, but if one strikes the nerve, the anesthesia may last for as long as nine months.

I wish to congratulate Dr. Muskat on his presentation, which leaves little to discuss. If he had had time I am sure he would have gone into the subject of the resection more thoroughly. The results of the resection are known and the difficulty these patients have, and I think the most important thing is to know just how and where Dr. Muskat divides the nerve.

DR. IRVING MUSKAT: The operation for section of the superior laryngeal nerve is relatively simple. Some of the early operators performed a resection and subjected the piece of nerve tissue to microscopic examination for verification. This is not necessary because the exposure and course of the nerve is definite. It is the only large nerve in that position, as it comes off below and in front of the outer cornu of the hyoid bone. By following the course of the superior laryngeal nerve from this point, one can trace it to the point of entrance in the larynx. Even this is unnecessary as pinching the nerve will produce reflex pain to the corresponding ear and also to the larynx. On cutting the nerve, all pain is instantly relieved.

Dr. Pollock referred to an article describing an extensive operation which is performed through a longitudinal incision along the anterior border of the sternocleidomastoid muscle, exposing the nerve at its origin and resecting it as it comes off the ganglion nodosum. The supposition that such an operation includes all the fibers of the nerve and is therefore more efficient is not valid, as the procedure I use is clinically perfectly efficient and much more simple.

The clinical effect of the procedure I have described is almost miraculous. The pain and dysphagia are relieved, and the patient again can sleep and take food with impunity.

From my clinical observation and testing of the sensibility of the mucous membrane, it is evident to me that there is an arborization between both the superior laryngeal nerves and the recurrent laryngeal nerves. The superior laryngeal nerve is a mixed nerve, carrying motor and sensory branches, and one might imagine that the recurrent laryngeal nerve is also a mixed nerve.

I have spoken of the decrease in secretions in the larynx and the hyperemia that follows section of the superior laryngeal nerve. Some have thought that this was due to sympathetic effect. Whether this is true or not, I do not know, but what is certain is this—that because the dysphagia is controlled the patient can expel the laryngeal secretions without pain, thereby giving the tissues a better chance to heal.

PROGRESSIVE DEAFNESS IN IDENTICAL TWINS (TWO PAIRS). DR. GEORGE SHAMBAUGH, JR. (by invitation).

This article was published in the ARCHIVES, in February, 1933 (**17**:171).

DISCUSSION

DR. ROBERT SONNENSCHEIN: There is not a great deal that I can add in the way of discussion of Dr. Shambaugh's paper. His illustrious father's membership in the Chicago Laryngological and Otological Society has, because of his national and international reputation, added great distinction to our organization. We are hopeful that when the time expires that is required by our constitution as one of the preprequisites for membership we shall be able to welcome the essayist to our midst.

This paper is one of great interest to the students of otology, for the etiologic factors of progressive deafness, especially of otosclerosis (better said otospongiosis), have engaged the minds of the research workers in our field for a long time. It has been felt by many that heredity has been one of the most important factors in the causation of this dreaded affliction, and a careful study of cases

of identical twins may, after all the contributing factors have been considered, throw considerable light on the origin of this affliction. Professor Draper says that the term human constitution in a medical sense "must properly connote that aggregate of hereditarial characters, influenced more or less by environment, which determines the individual's reaction, successful or unsuccessful to the stress of environment. Thus in this sense, there are two aspects to constitution, one which is inherited and inheritable (idiotypic) and another which is influenced and non-inheritable (paracytic). Quite clearly then the individual who presents himself for study is the up-to-the-moment question of the combined forces of heredity and environment. Such a specimen is technically called a phenotype and obviously he may vary by several degrees from his natural heritance (idiotypic or genotypic) pattern."

Siemans has stated that "Individuals that are similar in appearance (as phenotypes) may be very different from one another in their inheritance patterns (idiotypes). But reversely, individuals that are identical in their inheritance patterns may look very different as realized organisms (phenotypes)." In clinical medicine the problem is somewhat modified in that "predisposition to a given disease may well be a dominant character which cannot display itself until the appropriate disease arising from the clash with the specific external agent demonstrates its latent presence." In other words, the individual may have the hereditary tendency to otospongiosis, but it is not until certain changes occur in the organism, as at the age of puberty and during pregnancy, that the latent process becomes active.

Siemans has said that strictly speaking, "Twinning is twaining, or two-ing, namely; the division of an individual or an organ into two equivalent and more or less completely separate individuals or organs." "All that is necessary in order to get two individuals instead of one is to accomplish the division of an embryo into two equivalent regions. Each region is totipotent and soon reorganizes its own complete axiate relations and becomes a whole individual. When separation of the halves is incomplete we get in the case of whole organisms, double monsters, and in the case of special organs, merely double organs." He says further it is significant that twinning is especially characteristic of vertebrates.

It will thus be seen that cases such as Dr. Shambaugh has presented are of intense interest. If large numbers of persons could be seen and all environmental factors accurately studied, then it would be possible, as Dr. Shambaugh has stated, to determine whether heredity alone or whether heredity plus environment causes some of these diseases. If it could be shown in a comparatively large number of cases that even though one of the twins is exposed to many factors entirely different from those which the other twin experiences, but nevertheless the development of the otosclerosis or other forms of progressive deafness is identical in both twins, that fact would go a long way in proving that the essential etiologic factor lies in heredity, pure and simple.

DR. S. L. SHAPIRO: When Lucas wrote his treatise on chronic progressive deafness about twenty-five years ago, he used the term purely in a clinical sense; when Wittmaack published his recent article in the ARCHIVES OF OTOLARYNGOLOGY on the subject he specifically stated that chronic progressive deafness is not identical with otosclerosis. There is, in my opinion, a considerable tendency to use these terms synonymously, which often adds to the confusion associated with this condition. It is important to bear in mind that cases of progressive labyrinthine deafness (not in twins) have been reported by Alexander and others in which there was no evidence whatever of otosclerosis at autopsy.

The relationship between otosclerosis and impairment in hearing other than that due to fixation of the stapes is by no means clear. At least there is not, to my knowledge, an adequate explanation why a patch of otosclerosis in the labyrinthine capsule not involving either of the windows should cause deafness. In this connection it might be well to mention the view of Alfred Gray, of England, who recently has expressed himself again on this subject. He considers that in these cases the degenerative changes occur primarily in the eighth

nerve and that the pathologic process in the bone which may or may not accompany the disease is something incidental and does not by itself cause deafness.

DR. HARRY L. POLLOCK: I should like to know whether in the experience of Drs. Shambaugh they have found a case of progressive deafness in any one twin, or whether they have found otosclerosis in one twin and not in the other. I know a few such cases have been reported.

BILATERAL FRONTAL LOBE ABSCESS (CLINICAL REPORT). DR. SAMUEL SALINGER.

A. L., white, a girl, aged 16, was admitted to Michael Reese Hospital on Dec. 21, 1932, with a history of a cold in the head lasting three weeks. For the past few days there had been some headache and left frontal pain, with swelling of the left eye.

Examination disclosed a tense fluctuating swelling on the forehead over the left brow, marked swelling of both lids and tenderness over the supra-orbital margin. The eyeball was unaffected; there was no exophthalmos and no impairment of ocular movements. The temperature was 99.2 F., and the pulse rate, 72. Her general condition was good. A moderate amount of pus was seen in the left middle meatus.

A diagnosis of frontal sinusitis and subperiosteal abscess was made, and a simple incision down to the bone followed. A large amount of pus was evacuated, and a rubber tube drain was inserted.

During the next two days there was no apparent change in the appearance of the forehead and eye. The tube was removed, and little drainage followed. The temperature rose to 101 F., but receded the next day. A roentgenogram showed a considerable area of bone absorption in the frontal region to the left of the midline, and the left lid became more swollen and slightly fluctuant. In addition, it was noted that the patient at times became irritable, loquacious and incoherent, talking loudly and impertinently.

A diagnosis was made of acute osteomyelitis of the frontal bone, extradural abscess and possibly brain abscess. (The optic disks were pale, the margins slightly irregular, and the vessels engorged.)

The patient was operated on again on December 27. A wide exposure of the left frontal region was made through a triangular flap. The frontal sinus was found full of pus; the anterior and posterior walls were mostly absorbed, and a large sequestrum was found lying on the dura which was covered with granulations over an area approximately 2 cm. in diameter. As pulsation was plainly felt through the dura, the latter was not incised. The right frontal sinus was opened through the intersinus septum and was found to be full of pus. Drainage was effected both through the common opening above as well as through the nose. The posterior wall of the right sinus was palpated by probe and found to be intact. The external wound was left wide open and covered with a light pack.

Following the operation there was temporary improvement, but within twenty-four hours the patient became stuporous and failed to respond. The knee jerks disappeared, but otherwise there were no abnormal reflexes. In the next twenty-four hours the symptoms became more aggravated, and the pulse dropped to as low as 52. The wound was then spread open, and the dura, which was now tense and nonpulsating, was exposed. The dura was incised, and a brain searcher encountered a large abscess cavity at a depth of 1.5 cm. from the surface of the cortex. A large amount of pus was evacuated, and a rubber tube inserted. There was an immediate, though short-lived, improvement; the pulse rate rose to 80 and the patient appeared less stuporous. However, within the course of the next twelve hours the symptoms increased in severity; the stupor deepened into coma, the pulse and blood pressure rose, and the symptoms generally pointed to extension of the encephalitis or rupture into the ventricles. Death followed about twenty-four hours after the evacuation of the abscess of the left frontal lobe.

Autopsy, a report of which appears subsequently, disclosed a large abscess in the right frontal lobe the existence of which had never even been suspected, which

communicated with the anterior horn of the lateral ventricle. It showed also that the abscess in the left frontal lobe which had been opened had been thoroughly drained, as evidenced by its complete collapse, but nevertheless it had eroded into the ventricle, as had the one on the right side.

It is evident that the abscesses developed simultaneously in both frontal lobes and probably eroded into the ventricles at the same time. There was no reason to suspect involvement on the right side in view of the fact that all the symptoms and the uncovered pathologic process were on the left side. Even after the abscess on the left side had been evacuated and symptoms of encephalitis still persisted, it was felt that the only explanation could be that another abscess was present in the same lobe. This case again demonstrates the difficulty of locating an abscess of the frontal lobe in the absence of focal symptoms.

I am also impressed with the erosion into the ventricles, an occurrence that I have encountered in previous cases and which I believe is more common in the frontal than in any of the other lobes of the brain. The anterior horn of the lateral ventricle sweeps forward in an arc that brings it well within the substance of the frontal lobe and places it in the path of an abscess developing in a posterior direction.

Autopsy was limited to the head. There was a double right angle-shaped incision over the left frontal area with the edges of the wound gaping open. The vertical portion of the incision extended from the inner canthus of the left eye up onto the forehead and was 4 cm. in length; the horizontal portions extended from the middle of the vertical incision and ran through the left eyebrow. A black rubber drainage tube protruded from the wound from which there exuded some yellowish purulent material. The same material was seen dripping from the nose and mouth. There was an opening 2 cm. in diameter in the left frontal bone through which brain tissue could be seen. On opening into the skull, the meninges were found to be hyperemic. The dura was thickened over the region of the opening in the frontal bone. The saggital sinus contained clotted blood.

After the brain was hardened in formaldehyde, the subarachnoid vessels were hyperemic. Both frontal lobes, but especially the right, showed markedly distended and flattened gyri. The sulci had almost completely disappeared. The dura was attached to the lowest portion of the left frontal lobe, also extending into the orbital region. There was a small opening in the dura which led into the left frontal lobe. There was no evidence of an exudate in the subarachnoid region with the exception of the area mentioned before.

On section of the pons, a few petechial hemorrhages were seen.

On section of the brain, the right frontal region, and especially the white substance, was almost completely replaced by a large amount of dark grayish-green pus which was surrounded by a granular and ragged appearing tissue. These changes extended to the region of the precentral gyri. In these areas only a small amount of pus was found, but there was a yellow appearing meditullium in the midst of which a small cavity measuring 1 cm. in diameter was found.

The anterior horn of the right lateral ventricle was continuous with the abscess. In the corresponding regions of the left frontal lobe a cavity measuring 1 cm. was found. The cavity was surrounded by a gray appearing brain tissue which showed many petechial hemorrhages. Posterior to the cavity a communication could be made out between the cavity and the anterior horn of the left lateral ventricle.

The anatomic diagnosis was chronic osteomyelitis of the frontal bone, surgical incision (for drainage of the abscess of the frontal lobe), recent brain abscess (right frontal lobe), old brain abscess (left frontal lobe), perforation into the ventricles (bilateral) and organizing circumscribed leptomeningitis and pachymeningitis.

DISCUSSION

DR. ROBERT SONNENSCHEIN: Illustrative of the fact that these abscesses of the frontal lobe are sometimes deceptive, and that the process remains latent for a long time, let me briefly outline a case that occurred in a medical student some years ago, in whose case I had the assistance of Dr. Ira Frank.

Acute frontal sinusitis with severe headache and edema of the eyelid suddenly developed. The patient had a tremendous left middle turbinate, and although we are always afraid to perform any operative procedure during acute sinusitis, the obstruction was so great that we thought it necessary to remove the anterior tip of the middle turbinate. Further symptoms developed, and the patient was taken to the hospital. We found much pus in the frontal sinus but no erosion of the posterior wall. Drainage was instituted, and he seemed to make an uncomplicated recovery. After a number of weeks he suddenly had chill, high fever and stupor. Dr. Archibald Church saw him, and a spinal puncture was done; the fluid was cloudy. We again opened the frontal sinus and found the posterior wall still intact with no visible fistula. We removed the posterior wall. The dura showed nothing suspicious. A trocar was introduced into the frontal lobe, and a large amount of pus was evacuated. The boy died within twenty-four hours, but no necropsy was obtained.

This case demonstrates how difficult the diagnosis of abscess of the frontal lobe may be.

Dr. T. C. Galloway: It is well to recall that any brain abscess that has to be operated on in its early course is usually fatal. If recovery is to follow, operation should be performed after encapsulation has taken place, which is after from three to five weeks. However, such surgeons as Sachs think that in desperate cases at least tapping must be done, but recovery seldom occurs when early intervention is necessary.

It is worth remembering also that many brain surgeons in such cases attempt to reduce intracranial pressure by intravenous injections of hypertonic dextrose solution, to tide over the immediate emergency.

Dr. Samuel Salinger: I want to explain the logic of my procedure in this case. In the first place, we had an acute frontal empyema of short duration. Why did I not open the sinus in the beginning? Because it is a general experience that radical surgical intervention in these acute cases is contraindicated because of the danger of an acute osteomyelitis. Therefore, our first procedure, namely, simple incision and drainage, seemed rational. However, when after two days the condition progressed and threatening symptoms appeared, we proceeded to do a radical operation which disclosed the extensive pathologic process as previously described. At that time we made an opening into the opposite frontal sinus and were content with simple drainage, because the bony walls were intact and there was nothing to indicate an extension of the process on that side. Having later drained an abscess of the frontal lobe on the side where the original pathologic process presented, it could not possibly have entered our mind that we had missed anything. Even when subsequently the symptoms failed to subside, it was our feeling that another abscess was present, but we still felt that it was on the same side.

A few years ago I presented a patient as having been cured of abscess of the frontal lobe. A few months later the patient was returned to the hospital with symptoms of a brain abscess, and it was found on operation that a part of the original abscess had been pinched off and remained dormant.

New Adaptation of X-Ray Prints and Slides. Dr. Walter H. Theobald.

Photographic prints of x-ray films used for publication up to the present time have been more or less unsatisfactory. Positive x-ray prints which one sees in textbooks require description in detail and many of them have to be retouched. Likewise, the lantern slides made from x-ray films lose much of their detail and require considerable identification when presented.

This is a preliminary introduction of a process which involves lighting effects in the printing of negatives, and involves some change in the chemistry of the solutions used for the purpose of printing. This presentation is given to invite your criticism or your evaluation.

The prints are, after all, negative prints made directly from the negative film, at the same time giving a plastic effect. They give a topographic appearance, a third dimension or relief appearance on the flat picture. I think I can best

demonstrate what I mean by showing rapidly several of the prints made with this new method and comparing them with the old and then demonstrate their value in lantern slides. (Slides were presented.)

DISCUSSION

DR. ALFRED LEWY: I should like to ask how Dr. Theobald got these splendid results, whether by some difference in the lighting effects or by a change in the chemicals used.

DR. AUSTIN A. HAYDEN: The pictures Dr. Theobald has shown have particular interest for any one who is interested in photography, and for that matter for any one who is interested particularly in photography of the sinus.

Reduced to its simplest terms, the pictures that Dr. Theobald has shown are roentgenograms as they are seen in the shadow box. That is to say, any of the negative negatives that he describes, if the lantern were large enough to project an 8 by 10 plate instead of the 3¼ by 4¼, would have exactly the effect that Dr. Theobald has shown. The reason why these pictures bring out so much more detail is because a picture that has recorded on it the original sensitivity to light is always subject to more definite shades than one that has been copied into a positive picture of the slide. It has the increased advantage also, particularly so far as lantern slides and photographs are concerned, of allowing the observer to study something with which he is entirely familar. These x-ray pictures have been studied in shadow boxes for a long time. One had not familiarized oneself so much with the positives of these x-ray pictures because one seldom sees them, but a very much clearer definition of outline is possible by studying the x-ray picture as it was photographed on the original plate than if the positive had been photographed.

This matter came to my attention about four years ago. I do not say this to deprive Dr. Theobald of any priority in the discussion, but this happened to me when I was making a series of movies of the antrum. In that series an osteoma of the left maxillary sinus was being studied, and I was working with a motion picture camera which makes positive film, instead of the ordinary photographic camera which makes negative film from which the positive print must be made. I took a picture of the antrum, put it in the shadow box, measured for the footage very carefully, and, running the camera at the regular speed, I made an exact picture of what I saw in the x-ray picture, that is, a negative of the negative, as Dr. Theobald prefers to call it.

I think for purposes of demonstrations with lantern slides and for illustrations in a textbook that this method is of considerable value.

The Devry Corporation, at 1111 Center Street is constructing a stereoscopic camera that is to be sold here at the World's Fair, which is an adaptation of this same method of photography. This camera is a simplification of the French camera that uses standard 35 mm. motion picture film, but this particular camera is equipped to use film similar to the motion film that will develop positive instead of negative films, so that the film can be put into the stereoscope immediately after it has been developed and the positive picture can be seen.

To show you the possibilities that these people look forward to in the development of this camera, they are making these stereoscopes to sell for $1. I saw the original model recently, and it is an adaptation of this same method.

DR. SAMUEL SALINGER: I wish to call attention to an article that appeared in the *Zeitschrift für Hals-, und Ohrenheilkunde* last winter by Waldapfel which dealt with photomicrography by means of infra-red light. Compared to photographs taken under ordinary light, they showed far greater and finer details of cell structure and limiting membranes.

It is barely possible that this may have been the method employed by Dr. Theobald's photographer.

DR. WALTER H. THEOBALD: I do not claim to have made a discovery in making these prints. I did discover a photographer who does this work, and

applied it to x-ray films, but I am not entirely familiar with the procedure. It does require a change in lighting effects, but nothing so elaborate as polarized or infra-red light.

These pictures go further than Dr. Hayden mentioned, in that these flat pictures are stereoscopic. I do not believe any reference Dr. Hayden made includes just this thing. I am here to invite all the criticism I can get. I have made an effort to find out whether anything of this kind has been done before. Fifteen years ago a German made what was called a plastic picture, but a man who was familiar with it informed me it was nothing like the films I have presented, and that he had never seen anything that corresponded to this relief effect.

It will take a great deal more study to ascertain their value in interpreting pathologic processes. Sometimes I have felt that I could see more in these relief pictures than I could in the film itself. The study of pathologic conditions has not been sufficient to prove whether one sees more in the prints than in the film and further study is essential. I think the procedure will have a place, certainly for publication of x-ray films. Photographs and x-ray plates have to be carefully interpreted to evaluate the pathologic process that is present. They seem to lose detail, particularly when they are reduced in size.

Regular Monthly Meeting, April 3, 1933

CHARLES B. YOUNGER, M. D., *President, in the Chair*

MENINGITIS CURED BY SIMPLE MASTOIDECTOMY. DR. T. C. GALLOWAY.

G. H., a girl, aged 9 years, had an acute infection of the upper respiratory tract with running ears. On the thirteenth day there occurred dizziness, headache, severe occipital pain, fever and vomiting with progressive weakness, delirium and semicoma. Rigidity was marked, the Kernig and Brudzinski signs were positive, and the spinal fluid was very cloudy with 1,500 cells, mostly polymorphonuclears. No organisms were found on smear or culture. Culture of the blood showed hemolytic streptococci.

A simple operation on the mastoid was performed with wide exposure of the dura of the middle and posterior fossae. A normal looking, forward lying sinus was found in a sclerotic mastoid with softening of the tegmen and a few granulations overlying it. Repeated spinal punctures were performed, and two blood transfusions were given. The patient went home after three weeks apparently well.

DISCUSSION

DR. T. C. GALLOWAY: This is one in a series of five cases that Dr. Salinger, Dr. Pearlman and I have reported over a period of five years which taught the same lesson: that patients with meningeal symptoms, even with coma and large numbers of cells in the spinal fluid, without localizing symptoms, may successfully be treated with wide dural exposure and nothing else.

In my experience, quite a number of these patients recover under such management, whereas if too much surgery is attempted they do not. If the organisms spread rapidly in the arachnoid and subdural space radical measures will not cure the patient. These cases frequently respond to the procedure of simple mastoidectomy, and nothing is gained by attempting more without definite localizing signs like those named by Eagleton. Whether one does a radical or a simple mastoidectomy is a question of personal choice, but I feel that one can get adequate exposure without cleaning out the middle ear.

DR. ALFRED LEWY: To be confronted with meningitis is a very serious thing, and one should know what to do about it. I agree with Dr. Galloway that one should uncover widely the dura of the posterior and middle fossa. There is no time to find out whether the meningitis is generalized or localized, or to wait for

the result of culture of the spinal fluid. Operation is justified in all cases if the patient is not manifestly moribund.

Five years ago I presented nine cases of meningitis, with four recoveries. The patients were treated with ethylhydrocupreine hydrochloride, which is said to be a powerful antiseptic. In all the patients who died bacteria were present in the cultures of the spinal fluid, and this I think is the crux of the situation. In cases of meningitis with viable bacteria in the spinal fluid the patient rarely recovers. One of the four patients who recovered had bacteria in a smear of the spinal fluid, so this finding alone is not necessarily indicative of a fatality.

I think that one exception to the rule laid down by Dr. Galloway occurs when the disease has gone through the labyrinth. In one of my cases the child stopped breathing when turned on the side because the pressure was sufficient to interfere with the respiratory center. In translabyrinthine meningitis the cisterna pontis lateralis should be drained. As this cisterna includes the internal auditory meatus, such drainage is behind the labyrinth, and I believe offers hope when the infection is still localized in this region.

LARYNGECTOMY FOR LARYNGEAL CARCINOMA. DR. SAMUEL J. PEARLMAN.

DISCUSSION

DR. SAMUEL J. PEARLMAN: This man was operated on four months ago, and has since gained 50 pounds (22.6 Kg.) on a diet of high caloric content with tube feeding. He had an advanced intrinsic carcinoma, with no enlargement of the cervical glands. The laryngectomy was performed from above downward. He still has a slight stenosis of the tracheal stoma and continues to wear a tracheotomy tube.

AMYLOIDOSIS OF THE CORD. DR. SAMUEL J. PEARLMAN.

DISCUSSION

DR. SAMUEL J. PEARLMAN: This man is 70 years of age, and the case has no special significance apart from its interest as a rarity. The lesion appeared like a vocal cord polyp.

The diagnosis of amyloidosis of the cord was made after biopsy, as is usually the case. Amyloidosis in the upper respiratory passages is a rare disease; when strictly limited to the larynx, it is still more rare. There are only about sixty such cases on record. It does not, as a rule, occur with generalized amyloidosis, but is seen with amyloidosis confined to the respiratory tract. Not much is really known about the chemistry of the disease.

DR. PHILIP A. HALPER: Amyloidosis occurs as a part of a generalized or local condition. The upper air passages are more frequently involved than any other part of the body in local amyloidosis. In this area the larynx is the commonest site of involvement, and next in order is the trachea. The disease is also found in the nose, tongue, tonsils, etc. The pathology manifests itself as (1) subepithelial infiltration, (2) tumor-forming local amyloidosis and (3) amyloid degeneration in a preexisting tumor.

I reported a case last year before this society of an amyloid tumor of the vocal cord. The patient was a waiter who was quite an extensive smoker. He came in because of hoarseness. He gave a history of a syphilitic infection two and a half years previously, and was treated without much improvement of the larynx or the hoarseness. A small sessile granuloma was discovered on the right vocal cord, and was shaved off. A pedunculated mass in the region of the anterior commissure was removed under direct laryngoscopy; this proved to be an amyloid tumor of the vocal cord. The patient was examined from the standpoint of chronic degenerative disease, and the results were entirely negative. The only complicating factor in this case was the history of syphilis two and a half years before.

These cases are commonly not followed to necropsy, and it is a question whether or not other organs would show amyloid disease on postmortem examination.

TEMPOROSPHENOIDAL ABSCESS. DR. SAMUEL J. PEARLMAN.

DISCUSSION

DR. SAMUEL J. PEARLMAN: This girl, aged 15, has gained 15 pounds (6.8 Kg.) since she was operated on. On admission to the hospital she was taken to a medical ward because some respiratory infection was suspected. There they noticed some discharge from the ear, which was said to have been present only a few days. An otologist was sent for. Her temperature was 104 F., and a fine nystagmus was present, but there were no indications of meningitis. Some hearing was present in the affected ear, and it was felt that we should wait before attempting operation, on the basis that the labyrinth was alive and the severe symptoms could not be aural in origin. The next day she was much improved, and the internists discovered nothing pathologic.

She was then sent to the otologic ward, where she was examined from time to time. The temperature diminished greatly, and she had considerable improvement in hearing. On several occasions we arranged for operation and sent her back to bed. Finally we decided to operate. Because of an occasional headache a simple mastoid operation was performed, and mastoid infection was discovered. The dura of the posterior fossa was lying in the wound, and was covered with granulations; we thought that this explained the temperature curve. She was returned to bed, and did well for three or four days, when she began to have a fall in the pulse rate and vomited. We then diagnosed the condition abscess of the brain. There was nothing to give a clue to the localization except a distinct aphasia for names.

On reopening the mastoid we were confronted with granulations over the dura of the left posterior fossa. Nevertheless, we went into the temporosphenoidal lobe and at a distance of 4.5 cm. discovered foul-smelling pus. No drainage was instituted, and the patient was returned to bed. Three or four days later, headache, vomiting and a slow pulse rate developed again. A needle was inserted, and a small rubber drain put in place. After three or four days we put in a larger drain. Three or four days later, when the drain was removed, the floor of the abscess seemed clear, and all drainage was discontinued. The patient has made a good recovery and has returned to school.

The essential features here were an acute otitis media which gave few or no local signs except a moderate amount of discharge (the hearing remained good) and an early sepsis due to mild involvement of, and probable absorption from, the lateral sinus as a part of a pachymeningitis of the posterior fossa. When signs of abscess developed the only sign of localization was the presence of an aphasia for names.

The favorable signs were the absence of any finding of cerebritis, as evidenced by an absence of exhaustion, the complete absence of any signs of leptomeningitis and the fact that the lateral sinus was not thrombosed. Under such circumstances an uncomplicated abscess of the brain offers a good chance for recovery.

RAMSAY HUNT DISEASE. DR. SAMUEL J. PEARLMAN.

DISCUSSION

DR. SAMUEL J. PEARLMAN: Herpes zoster occurring about the ear may be classified as of three types. All herpes zoster is due to involvement of ganglions of the sensory nerves, often with symptoms of an increased pressure and lymphocyte count in the spinal fluid. The three types are: herpes facialis, due to involvement of the gasserian ganglion, with lesions in the area of the distribution of the auriculotemporal nerve; herpes occipitocollaris, due to involvement of the second and third cervical root ganglions, involving the area supplied by the great auricular nerve, and the herpes which Ramsay Hunt stated is due to involvement of the sensory branch of the facial nerve by way of the geniculate ganglion, so-called herpes zoster oticus, the Ramsay Hunt syndrome or polyneuritis acustica. In this type one may have herpes coupled with facial palsy (involvement of the geniculate ganglion alone), herpes coupled with facial paralysis and deafness

(involvement of the geniculate and the vestibular ganglions) and herpes coupled with facial paralysis and deafness (involvement of the geniculate and acoustic ganglions). On occasions a limited area of the skin about the ear is attacked by herpes owing to involvement of the vagoglossopharyngeal ganglions.

In these conditions the pain precedes the herpes by several days. With no deafness or vestibular phenomena recovery usually takes place, but it may require several months. Vestibular or cochlear involvements are apt to show signs of permanent impairment. A good account is given of these conditions in the textbook on otology by Thomas and Yates.

Dr. Alfred Lewy: I had a similar case of Ramsay Hunt's disease in a middle-aged woman who came down with Ménière's syndrome, combined with facial paralysis; in a few days there was an eruption of herpes in the canal of the ear and down the neck. This patient has made practically a complete recovery so far as vestibular function is concerned, but she still has a slight drooping about the corner of the mouth. The facial nerve has not recovered as fully as the eighth nerve.

Dr. Walter H. Theobald: What treatment was used for the herpes zoster oticus? Dr. Guttman reported several cases of "shingles" in which there was no treatment, so to speak, except local applications for relief of pain. Two patients whom I saw this winter were treated with injections of sodium iodide. One patient suffered severe pain, for which morphine gave no relief. Sodium iodide was injected intravenously, in doses of 2 grains (0.13 Gm.) in 10 cc. of water every day, and this caused rapid subsidence of symptoms. This treatment, I believe, is quite new and has been used for intercostal herpes zoster.

Dr. M. Reese Guttman: In 1925, during the epidemic of influenza, I had occasion to report twenty-seven cases of herpes zoster oticus that were seen in the practice of Dr. Beck and Dr. Pollock. It is not entirely true that we did not do anything for them. We used metacresol acetate in the canal for relief of the pain. We employed nothing aside from that, except the usual measures for influenza.

The high incidence of herpes zoster oticus in connection with influenza is well known. Of the twenty-seven cases I think only one was complicated by facial paralysis, and that cleared up within two or three weeks. Pain persisted after the eruption disappeared, but it was fairly well controlled by the use of metacresol acetate.

Influence of Sir Felix Semon on the Development of Laryngology. Dr. Ira Frank.

In 1875 Felix Semon came to London from Berlin. He was just admitted to medical practice, an alien, a stranger to the customs and habits of his new surroundings, keenly sensitive to the anti-Semitic feelings openly manifested by those with whom he associated and entering on the practice of a specialty which was then under a cloud, yet within a comparatively short term of years, he obtained the recognition of laryngology by the profession against the opposition of some of the highest authorities and institutions, and won for himself the highest honors in the land of his adoption and a recognized place for himself and for laryngology throughout the world.

Semon's early advance to success was facilitated by his connection with the famous Morell Mackenzie, Great Britain's most famous laryngologist, who gave him a position as clinical assistant in his throat hospital and helped him to a membership in the Royal Medical and Chirurgical Society. He worked diligently and brilliantly in establishing laryngology as a special branch of medicine, having to face the opposition of members of the profession and hospitals in this regard. He wrote incessantly, in both English and foreign journals, advocating this view. At the International Congress of Medicine, held in London in 1881, his efforts were crowned with success, and here for the first time, a section on laryngology was established. The hospitals soon fell into line, and St. Thomas's Hospital appointed Semon special physician for diseases of the throat. The Royal College of Physicians elected him a fellow, recognizing the new specialty.

In 1884, Semon founded the *Internationales Centralblatt für Laryngologie, Rhinologie und verwandte Wissenschaften*, of which he continued to be editor until close to death. He was elected an honorary member of most of the newly formed laryngologic societies throughout Europe and America. His writings in the *Centralblatt* influenced and standardized the practice of laryngology throughout the world. He opposed the union of otology and laryngology, preferring to keep the latter pure and simple, and thus opposed American views. Nevertheless, he was in no sense a narrow specialist.

As a writer, Semon's name will always be associated with laryngeal paralysis and malignant disease of the larynx. Both of these subjects were materially advanced by his pathologic researches and his clinical observations. He stated what is now known as "Semon's law" in connection with laryngeal paralysis. His work, in association with Sir Victor Horsley, on the laryngeal nerve is classic. Semon also did some original work on the association of the thyroid gland with cretinism, myxedema and cachexia strumipriva.

Apart from medicine, Semon was a man of the highest culture and a brilliant conversationalist. He was well acquainted with the masterpieces of English, French and German literature as well as with the ancient classics. His most distinctive artistic gift was music. His home was a rendezvous for distinguished musical and other artistic people.

The growth of laryngology in the United States was greatly influenced by Semon's writings, and American laryngologists contributed frequently to his *Centralblatt*. Dr. Lefferts, of New York, was his devoted friend for forty years, and Semon spoke of him as a most faithful and indefatigable collaborator. Semon visited the United States in 1904 and met most of our leading laryngologists. He also addressed them in a special paper on the "Relation of Laryngology and Otology to Other Arts and Sciences." He died in 1921.

DISCUSSION

DR. J. A. CAVANAUGH: It is difficult to add much to the life of a great man after it has been so excellently delineated by the pen of Dr. Ira Frank. However, I have a keen sense of appreciation and deem it an honor to offer homage to a personality like that of Sir Felix Semon. Felix Semon possessed all the real qualities of a man and was always ready to aid and give support to his fellow man. He was a lover of all the sciences, music, art, medicine, etc.

Music was one of his hobbies, and through music the soul learns harmony and rhythm. Music molds character, brings refinement of feeling and lends grace and health to the soul and to the body.

Felix Semon was a great seer, visualizing what the future had prepared for him because of his Semitic heritage as well as his own qualifications for success. After careful weighing of ifs and ands he chose the field of medicine as his career.

Felix Semon left his home in Berlin early in life to battle in a mysterious world, knowing little of what was before him; yet he seemed always to find a way out and attain what he most desired.

The fact that he was received universally by friendly hands and especially by his non-Semitic colleagues is proof of an extraordinarily pleasing personality. True, he had his likes and dislikes, but he always possessed a logical reason for his feelings.

Felix Semon was not a pugnacious character, yet when integrity demanded he stepped forward like a man and was found with his seconds ready to substantiate his position, as was the custom in those days.

Dr. Semon, not finding opportunities suited for his future in Vienna, trekked to London. Here he made himself familiar with all centers of medical training, carefully studying the separate branches to decide which he would follow, and he finally decided on laryngology. His aim always was to reach the top of the ladder in whatever he undertook, so we find him on the first rung under the

tutorship of no less a leader than Sir Morell Mackenzie. He applied himself most patiently and diligently to this branch.

Semon was constantly on the alert to improve himself, not only in his chosen art but also in the arts that he loved, and he was found taking his place in society as well. He was fond of sports, developed readily the English feeling of sportsmanship and shared this enthusiasm.

Even though he selected laryngology as his specialty he never lifted his fingers from the pulse of things in general medicine and surgery. He has disseminated his knowledge throughout the world. The literature is filled with writings and observations made by Felix Semon. Time will not permit enumerating them, but we raise our voices in thanks to him for the many facts and observations that he has passed on to posterity. Chevalier Jackson spoke of him as one of the greatest authorities in laryngology. Our sympathy is with Felix Semon, for his road to success was a rough and winding one, but struggle is the law of growth.

Sir Felix Semon was a man of great tolerance, who adhered throughout life to a philosophy that brought him happiness and which he acquired through quiet reflection. His path through life in all its phases was by the way of the golden mean. As we stop to view him through the glass of time, what an inspiring spirit! A thinker? Yes, we have all witnessed the thinker standing amid the surprised, incredulous group of nonthinkers who feel the presence of a brain. Opportunities are always open to talent wherever it is born, so Felix Semon stepped forward. As a man clambers to the top, enemies arrive, but Felix Semon, knowing he was right, did not flinch; believing in the Greek adage, "Life is the gift of nature but beautiful living is the gift of wisdom," he forgave them.

Dr. Robert Sonnenschein: It is not my intention to discuss the excellent and comprehensive paper of Dr. Frank, but simply to bring before you a few items of interest to me, and I trust to you. The history of medicine has always been of great interest to me. I think it is well that we all strive to perfect ourselves in the attributes of our profession, and I believe that study of the history of men who made the science great gives a background that nothing else can furnish. Hobbies are things that many people ride, and my only regret is that I waited until about six or seven years ago before I adopted one. Several years ago I began collecting portraits of medical men. Unfortunately, when requested to send a photograph, many colleagues replied that they had none on hand, but would send one the next time they had a sitting, but they seldom did. Through the amiability and generosity of my late friend, Dr. Emil Mayer, I was willed three interesting items connected with the subject of tonight, three different photographs of Sir Felix Semon, all autographed and presented either to Dr. Mayer or to his wife. Also, I have a menu card of the dinner which was given in honor of Sir Felix and Mrs. Semon by Dr. Mayer at the time of the former's visit to the United States in 1904. (Photographs and other mementoes were exhibited.) The most interesting thing about the menu card is the collection of signatures that appear on it.

There were notices in the newspapers at the time of the visit of Sir Felix, one relating to cancer cures and one to the banquet given him; another interesting item which I have is a letter to Dr. Mayer from Sir Felix, in his own handwriting.

I am egotistical enough to claim some relationship to Sir Felix Semon, in that I also had a fracture of the lower end of the femur, which, however, was not received in so aristocratic a manner as his. He fell from a horse, while I was struck by a cheap automobile.

Here I have Semon's book, "Forschungen und Erfahrungen," which contains several letters that passed between Rosenbach and Sir Felix Semon, relative to the subject matter referred to by Dr. Frank.

I believe that the study of the history of medicine is not only interesting but valuable. When we see what some of the prominent men of this country, such as Leroy Crummer of Los Angeles, Dean Cutter of Northwestern University, Francis Packard of Philadelphia and others, have done in this way, it is stimulating. I am therefore grateful to Dr. Frank for his paper tonight.

Dr. Joseph C. Beck: I believe that there is no other man here tonight who attended the banquet at which Sir Felix Semon was our guest and the guest of the late Dr. Fletcher Ingals—unless it is perhaps Dr. Kenyon. I had barely entered the specialty at that time. I was reminded by the address this evening of two men in an allied specialty, particularly the late Mortimer Frank, a cousin of Ira Frank's, who was a fine historian in ophthalmology and who was taken away from us too early in this work. The other man who joined the Chicago Historical Society at the same time was Samuel Friedberg. I think that his collection is still intact and held by his family.

On the occasion of Sir Felix Semon's visit to Chicago, as we entered the dining hall we found a large round table for the seniors—Rhodes, Freer and others—and from this center table extended a long table at which the younger men were seated. Of course, to Sir Felix, the formation of the tables should have suggested the shape of a laryngoscope, but he said that he thought "it represented a Kelly pad." It was an interesting evening, and I shall never forget it. I am grateful to Dr. Frank for presenting this paper.

Dr. E. L. Kenyon: I do not recall whether I was present at the dinner to Sir Felix Semon or not, but it occurred to me while listening to the paper that the reason for Semon's law has never been discovered. I do not speak, however, from the standpoint of one who has gone into the literature and knows all about it. As I recall, Semon conceived the idea that the nerves supplying adduction and those supplying abduction possessed different degrees of vulnerability. Recent knowledge seems not to have confirmed any such conception. Something unknown at the time of Sir Felix Semon may throw light on his law, something regarding the peripheral muscular action of the larynx in abduction and adduction. In abduction but one set of muscles are in action, the crico-arytenoidei postici, while in adduction, besides the intrinsic adductor muscles, the strong muscles extrinsic to the larynx are also in action, and the extrinsic muscles remain fully competent. Moreover, the cricothyroideus is wholly, and the interarytenoideus partly, innervated by the superior laryngeal nerve, each muscle presumably being more effective in action than the other intrinsic adductor muscles, which are supplied wholly by the partly disabled recurrent laryngeal nerve. Since adduction results from the action of both competent and incompetent muscles, it is hard to see how precise normal cooperative activity of movements of the laryngeal organs could take place, while the vocal cords are employed for speech. It seems reasonable to assume in adduction for speech, a distorted action of a character which the partly disabled abductors cannot overcome.

Dr. Samuel Salinger: Dr. Frank spoke of Semon's great work on the innervation of the larynx. I possess an original copy of that monograph. Since hearing Dr. Frank I consider that it has taken on added value.

Dr. Frank J. Novak, Jr.: This is one of the best written papers that I have had the pleasure of listening to for a long time, and also one of the most interesting.

Dr. Ira Frank: I can add nothing, but wish to thank the gentlemen for their interesting discussion, and particularly Dr. Sonnenschein for bringing down his interesting material.

Manifestations of the Head and Neck in Metabolic Disorders. Dr. Harry L. Pollock.

My object in presenting this subject is to draw attention to some of the less common symptoms of the head and neck associated with an alteration of metabolism, which, by virtue of their remote origin, are likely to be overlooked.

In August, 1932, a woman, aged 54, was referred to me because of an irritation and scratching in the throat of several months' duration which had not been relieved under the care of her family physician. Examination of her throat disclosed the presence of two smooth, oval, pea-sized, yellowish-brown, freely movable nodules behind the right posterior pillar. There were no other positive findings in the head and neck, except small yellowish plaques in the skin of the

eyelids. The throat did not respond to local application, and the patient was advised to have an examination by an internist, followed by surgical excision of the nodules. Fairly well advanced diabetes was found, and proper treatment was instituted. A few months later the patient returned for observation, stating that the symptoms in the throat disappeared several weeks after the beginning of the antidiabetic regimen and that she was anxious to avoid operation. On reexamination the nodules were still present, but were definitely smaller. Operation was postponed, and the patient was advised to return for further observation if symptoms recurred.

It appears that only in the last decade have changes in the upper air passages caused by abnormal metabolic processes been subjected to investigation, and this study has been greatly aided by the newer developments in chemical analyses of blood and tissue. The most frequent cause of such symptoms of the head and neck is xanthoma, which is more common in women than in men, and usually makes its first appearance about the eyelids. Xanthoma of diabetic origin manifests a tendency to spare the eyelids and locate in the mouth, where the lesions progress rapidly, but may spontaneously disappear. The diagnosis can be clinically established, especially when there are associated dermal lesions. Definite verification may be obtained by histologic and histochemical means. Appropriate treatment of the associated metabolic disease will at times cause these lesions to recede. Under the general heading of xanthomatosis one must include the symptom complex of the Schüller-Christian syndrome.

Extracellular cholesterosis, first described in 1930 by Kerl in Vienna, is either rare or unrecognized. The lesions appear on the skin and the mucous membrane of the upper air passages as yellowish-blue nodules of glassy transparency, and are particularly associated with local varicosities. In 1924 Urbach and Wiethe described a form of lipoidosis characterized by the extracellular deposition of acetone-soluble lipoid in physical combination with an unknown albumin, which they named lipoid proteinosis. This disease usually begins in the first few weeks of life with the symptom of hoarseness. The course is chronic, and the lesions first appear in the laryngeal mucosae and later in the skin.

Another form of deposition to be considered in connection with manifestations of the head and neck is local amyloidosis, which is most common in the conjunctiva and the air and food passages and has no relation to the general form, but is probably associated with some local disease.

Another uncommon deposit which may be encountered is that of calcium. Hajek reported finding calcium deposited in a chronically inflamed antral mucosa and also in the tonsillar capsules of patients with chronic tonsillitis.

In connection with the deposits of dye and pigment, the most common form encountered is icterus, and the most significant localizations are on the inferior surface of the tongue, epiglottis, vocal cords and tracheal mucosa.

Of much more frequent occurrence in the domain of the otolaryngologist are the sensory disturbances caused by defects of digestion and endocrine function, frequently causing sneezing, nasal blockage and a watery discharge. With these conditions one might associate Quincke's edema and urticaria, which are considered due to intestinal absorption of split products. The rational therapy in these disturbances is a change of diet and catharsis.

The parathyroids which normally control calcium metabolism may, under certain conditions, function below par and allow a decrease of blood calcium with the development of tonic cramps. A probable example of this is laryngismus stridulus in children. Alteration of ovarian function also causes a group of symptoms in the upper respiratory tract which are well known.

DISCUSSION

DR. OTIS H. MACLAY: This is a timely and interesting paper, which brings to mind many rare conditions. Otolaryngologists are not very conversant with these cases and should be placed in a position that insures an accurate diagnosis.

Through seeing many patients in clinics and in private work one anticipates what is to be found before one investigates. Since many conditions are always present it is only natural to consider the examination complete without demonstration of the unusual. This article should be a diagnostic spur. Dr. Pollock is to be congratulated on having brought this out and on presenting this excellent paper. The paper not only is educational but will be a great help in looking up the literature. I have found many articles on diffuse amyloid growths, but there is little in the English literature on their localization in the throat or larynx. From this standpoint, this paper is a valuable addition to the libraries. It will aid in making diagnoses. Patients are repeatedly seen with some complaint which seems slight but which is of considerable trouble to them, not only as a local irritation but, what is more important, as a cause of much worry and anxiety, since they commonly imagine it to be of serious import. Repeated examinations without relief only intensify in the patient's mind the seriousness of his condition.

The appeal of these worried patients has been greatly intensified by various organizations throughout the country that have put out propaganda regarding cancer. Patients come in greatly worried about lesions on the tongue or along the cheek which are not at all marked or serious. If the examiner were more familiar with these rare lesions he would probably be able to make a diagnosis in many cases in which there has not been a definite reaction of a serious nature, and so would aid in eliminating this cancer phobia.

Apparently, xanthoma follows as a result of trauma. Whether trauma is a definite factor in the etiology of the disease I do not know, but I shall mention one case which is similar to one referred to by Dr. Pollock. The patient was a child in whom lesions developed following a bump on the head. A soft doughy mass developed which seemed to remain quiescent for a while; later other areas on the skull became soft, and finally a diagnosis of xanthoma was made. Treatment with radium produced an apparent cessation. However, remissions occurred later in several areas. The excess of lipoid in these cases is an essential feature. Lipoid acts on the vascular endothelium as an irritant or on previously injured tissues.

I do not know whether radium is used alone more frequently than roentgen rays, or whether a combination of the two is used.

The propaganda concerning cancer has impressed me because of the many patients I have seen who have been greatly worried. They may have some slight irritation from a tooth or something else that can be relieved, and they can be reassured. The great thing is not to overlook but to look over these cases and relieve the apprehension of the patient.

DR. SAMUEL SALINGER: This is undoubtedly the dryest subject that I have even encountered in otolaryngology. I have two articles on this subject which I use for insomnia, and they never fail.

There are a number of types of metabolic deposits in the mucosa of the throat which are difficult to recognize unless one has seen them before. There is an excellent article on this topic by Wiethe in the *Zeitschrift für Hals-, Nasen- und Ohrenheilkunde* (**32**:342, 1932) which is splendidly illustrated by colored plates portraying some of the lesions which Dr. Pollock described.

DR. HARRY L. POLLOCK: I wish to substantiate what Dr. Salinger said. This is a dry subject, but, judging from the foreign literature, these cases are quite frequent and are overlooked. As I recall some of the cases of tumors around the eye seen fifteen or twenty years ago, I think that if we had known more about this condition we could have made better diagnoses. A microscopic section of amyloid tumor and one of xanthomatosis were shown tonight, simply to draw attention to the things that I presented in the paper.

DR. OTIS H. MACLAY: Has the cautery or diathermy ever been used in the treatment of these tumors?

DR. HARRY L. POLLOCK: Not to my knowledge. They are usually removed surgically.

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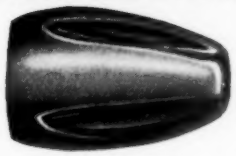

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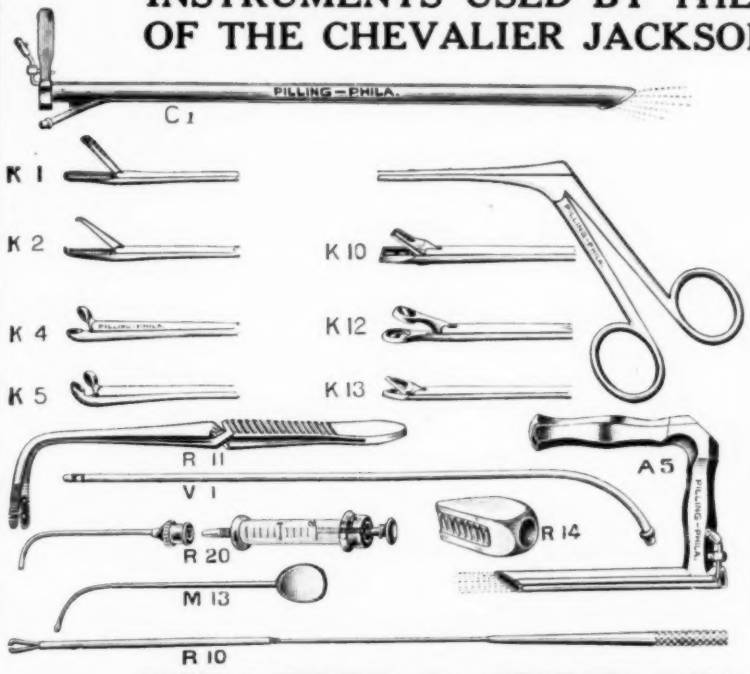

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